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SERVICE PARTS MANUAL



SERVICE PARTS MANUAL

800

DME

This manual contains factory recommended procedures for servicing and maintaining the Cessna 800 DME. This information is applicable to all Cessna 800 DME units used in Cessna Aircraft. This manual is divided into seven sections, each section containing the necessary information and a parts breakdown to assist in the overhaul and replacement of parts on each respective Cessna 800 DME unit.

This information is supplemented and kept current by Service Letters and Service News Letters published by the Cessna Aircraft Company. Recommended replacement parts for this system are available from Cessna Service Parts center.

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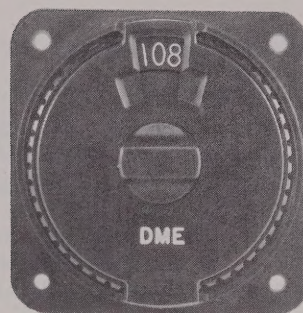
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INDICATOR

C582601-0201 (RED LIGHTING)
C582601-0204 (WHITE LIGHTING)



CHANNEL SELECTOR

C582601-0202 (RED LIGHTING)
C582601-0205 (WHITE LIGHTING)



C582601-0101 RECEIVER/TRANSMITTER

SECTION I

General Information

1.1 INTRODUCTION

The Cessna DME 800 is a Distance/Ground Speed Measuring unit. This compact unit is primarily designed for use in medium aircraft at altitudes up to 40,000 feet.

The Cessna DME 800 electronically converts elapsed time to distance, by measuring the length of time between the transmission of a radio signal to a preselected VOR/DME station and reception of the reply signal. This distance is then indicated in nautical miles on the Range/Speed/Time to Station Indicator. (Distances of 0-150 miles in 0.1 mile increments.) This distance, measured on a slant, from air to ground, is commonly referred to as slant-range distance and should not be confused with actual ground distance. The difference between ground distance is smallest at low altitude and long range. These distances may differ considerably when in close proximity to a VOR/DME facility; however, if the range is 3 times the altitude or greater, this error is negligible.

The effective range of DME depends on many factors; most important being the altitude of the aircraft. Other contributing factors to DME's effective range are the location and altitude of ground transmitter, transmitter power output, degree of maintenance of the DME system and maintenance of the ground facility.

The tracking speed feature incorporated in the Cessna DME 800 measures the rate of change in DME range with time. This speed is then read from 0 to 600 knots in 1 knot increments.

The receiver/transmitter unit contains the complete transmitter, receiver, power supply, range speed and time to station circuitry. The range speed and time to station indicators appear on the panel mounted indicator. This indicator can be installed in either a 13.75 or 27.5 volt dc aircraft by simply placing the power supply switch in the desired position, and installing the correct fuse and panel lamp jumpers.

1.2 PERFORMANCE SPECIFICATIONS.

INTERROGATOR

TSO COMPLIANCE: TSO C66 Cat. B.
CHANNELING TIME: 4 seconds maximum.
MAXIMUM ALTITUDE: Operational up to 40,000 feet altitude.
CRYSTAL CONTROLLED: 100 UHF Channels.
FREQUENCY RANGE: 1041 mc to 1150 mc.
POWER OUTPUT: 70 watts peak pulse power nominal.

RECEIVER SECTION

TSO COMPLIANCE: TSO C66 Cat. B.
POWER REQUIREMENTS: 13.75 volts $\pm$ 20% at 5.5a
27.5 volts $\pm$ 20% at 2.75a in track mode.
FREQUENCY STABILITY: $\pm$ 0.01%.
CHANNELLING TIME: 4 seconds maximum.
SEARCH TIME: 6 seconds maximum.
RANGE: 0 to 150.0 nautical miles in 0.1nm digital increments.
RANGE ACCURACY: $\pm$ 0.1 nautical miles or $\pm$ 0.2% or range, whichever is greater.
CRYSTAL CONTROLLED: 100 UHF Channels.
FREQUENCY RANGE: 978 mc to 1213 mc.
MEMORY: 12 seconds typical with automatic distance interpolation during this time.
ACQUISITION SENSITIVITY: -80dbm across the band for lock-on in 4 out of 5 searches.
LOCK-ON AND TRACKING: Lock-on and track at speeds in excess of 1,000 knots.
GROUND SPEED ACCURACY: $\pm$ 2 knots or $\pm$ 1% of reading, whichever is greater.
AUDIO OUTPUT: 50 mw of identity tone into 600 Ω adjustable load.
TIME TO/ FROM STATION: 0-60 minutes in 1 minute increments, accuracy $\pm$ 1 minute or $\pm$ 5%, whichever is greater. Time over station is only accurate when on direct course to or away from the station.

SECTION II

Principles Of DME

2.1 BASIC DME ELEMENTS AND PRINCIPLES.

Distance measuring equipment is an outgrowth of radar ranging techniques, whereby a distance is determined by measuring the round-trip time of travel of radio pulse signals between the two points in question. In DME, however, instead of a cathode ray tube display, a direct reading indicator is used to display the distance. Also, instead of depending on natural reflections or echos for the return trip of the pulses, a radio "transponder" or "beacon" is used to produce artificial echos. These artificial responses are stronger, and their radio channel positively identifies the source of the "echo" and hence the geographic location of the echoing point.

Referring to Figure 2-1, the airborne transmitter repeatedly sends out very short, very widely spaced "interrogation" pulses. These are picked up by the ground beacon receiver, whose output triggers the associated transmitter into sending out "reply" pulses on a different channel. These replies are finally picked up by the airborne receiver. Timing circuits automatically measure the round-trip travel time, or interval between interrogation and reply pulse, and convert this time into electrical signals which operate the distance indicator.

In system operation, a given ground beacon will be interrogated by a number of aircraft which are within range and which have tuned to its channel. The ground beacon will then reply to all interrogations, and each aircraft will receive the sum total of replies to all aircraft. To permit interference-free operation under such normal conditions, it is arranged that each aircraft's interrogation pulses occur at a rate that is intentionally permitted to "jitter" or vary (within certain limits) in an irregular or random manner. The jitter effect is obtained essentially by permitting a randomly modulated timing circuit to exercise gross control over the interrogation rate. In order to determine which ones, among all the reply pulses received on a given aircraft, are replies to that aircraft's own interrogation pulses, a stroboscopic "search" process, entirely automatic in operation, is employed.¹

2.2 OPERATION OF THE DME STROBE.

The strobe principle locates the proper reply pulses by finding the one fixed time delay, measured always from the DME's own previous interrogation pulse, at which a reply pulse is repeatedly received. Because interrogation pulses from other aircraft are nonsynchronous or random with respect to the given aircraft's interrogation pulses, reply pulses corresponding to such "foreign" interrogations will not be received regularly at any one fixed (or slowly changing) time delay, on the given aircraft.

The DME searches automatically each time the airborne set is initially tuned to a new ground-beacon channel, or if there is some major interruption in the radio signals. The strobe scans, progressively, various time delay intervals by means of a sliding "range gate" or "time slot". It quickly tests each time slot position for the number of successive reply pulses received within a certain uniform checking period.² If no replies or only sporadic replies are received, the time slot is advanced to test a slightly longer time delay interval; and so on. When, at some particular time delay interval, safe evidence of recurrent replies is detected (by a counting process), the search is completed and stopped, since this condition is fulfilled only by reception of the desired number of reply pulses. Those pulses are the only ones which are always received in synchronism with the given aircraft's own randomly jittered interrogation pulses.³

¹ In conventional usage, stroboscopic refers to an optical technique in which a periodic motion (rotation or vibration) is apparently "stopped", or its frequency is determined, by illumination with a flashing light source. The frequency of the flash is matched to that of the moving object. As used in radar and DME, stroboscopic or "strobe" refers to an analogous electronic technique wherein a particular set of recurring pulses is located in point of time by matching to their periodicity an adjustable electronic time-gate. As a mechanical analogy, consider droplets dropping from a water faucet. If a slit were interposed between the faucet and a cup, and the slit were opened for brief instants at a particular rate, an accumulation of water in the cup would be evidence that the mechanical time-gate (slit) had the same periodicity as the faucet-dripping.

² To return to the previous mechanical analogy, this is equivalent to the number of droplets of water falling through the periodically opening slit into the cup.

³ To pursue the mechanical analogy still further: Suppose a spout emits what seems to be a completely irregular succession of droplets. One could determine if among the droplets there is one regular series, by gradually varying the timing of the mechanical slit, to see if at some particular slit opening rate drops always fall through it.

Thereafter, the unit "locks" on to the proper pulses and transfers over to "track" operation. By this term it is meant that the delay setting of the timing circuits automatically and continuously follows any normal variations in the time delay of the proper reply pulses. Such variations will occur if the aircraft's distance is actually changing as a result of its flight path, but are necessarily very small because of the relationship between interrogation rates and actual aircraft speeds. This relationship is discussed next.

All of the time that the DME is locked on to the proper reply pulses during the tracking process, the time delay setting of the range gate is a proportionate measure of the aircraft's distance from the ground beacon (approximately 12 microseconds round-trip travel time per nautical mile). The circuitry that varies the time delay of the time slot is used to position corresponding numerical indicators on the distance readout, by means of electrical control signals.

The tracking circuits have a "memory" provision, so that if for some reason reply signals fail to be received during a certain short length of time, up to approximately 12 seconds, the pre-existing distance indication will be without the search operation being restarted.

2.3 DUTY CYCLE IN DME.

By strobe principles, which are common to all types of DME, many (more than 100) aircraft may simultaneously, and without mutual interference, obtain service from one ground beacon. Pulse interrogation rates vary from each aircraft as to the type of DME. General aviation DME repetition rates may be approximately 30 per second continuously or 150 per second when searching and 25 per second while tracking. The reason for the 150 search rate is to reduce required search time. The overall average rate is considered to be about 30 per second, on the basis that the average aircraft within range will be "tracking" 95 percent of the time and "searching" 5 percent of the time. The pulses are very narrow, of the order of 3 microseconds. Hence, the "duty cycle", or percentage of time during which R-F energy is actually being transmitted, is very low. The average interval between successive DME interrogation pulses from one aircraft is approximately 33,000 microseconds, the average interval between successive reply pulses to 100 aircraft is approximately 370 microseconds. It is evident that in DME operation, even with 100 aircraft receiving service from a beacon, the R-F channels are mostly "empty", very large spaces existing between successive pulses. (These spaces are partially used in Tacan to insert information for other navigational functions.)

⑤ DISTANCE INDICATION

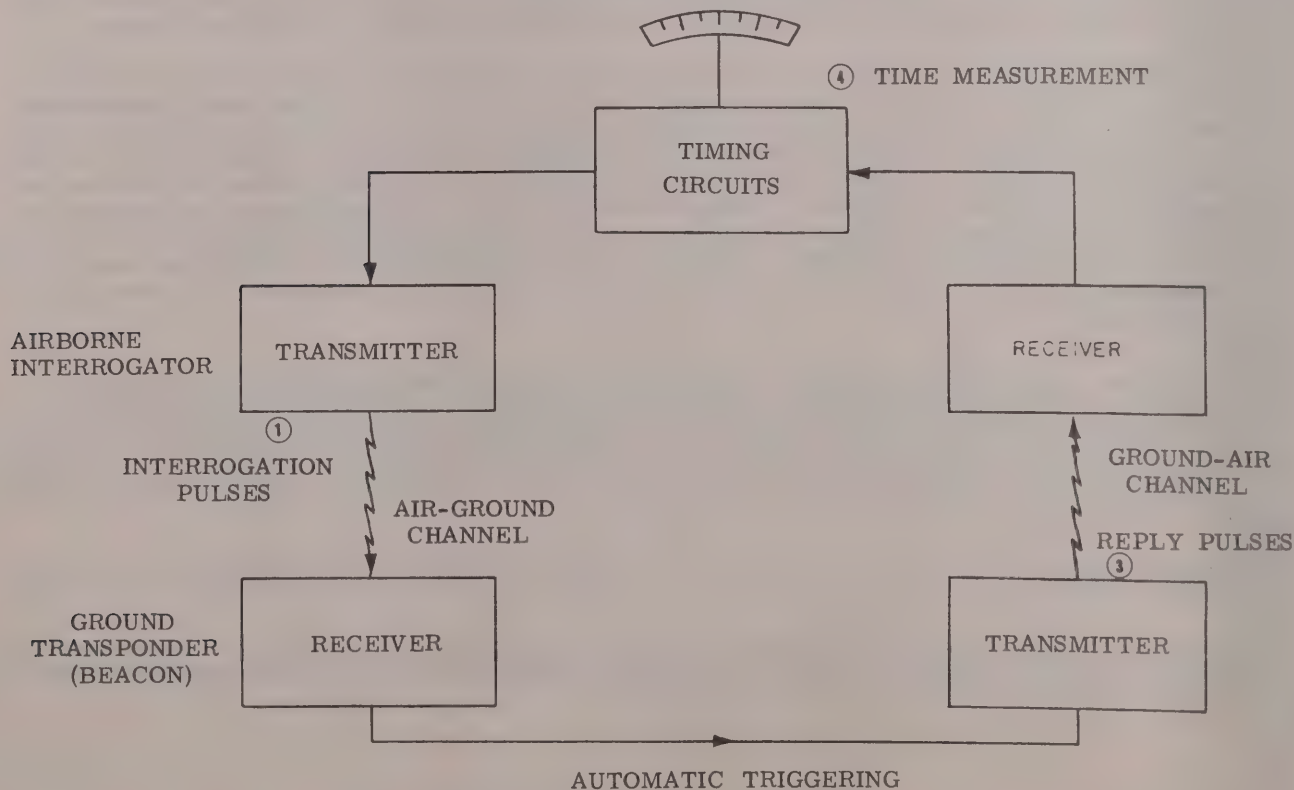


Figure 2-1. Elements of DME System

2.4 TWIN PULSE TECHNIQUE IN DME.

The spacing between the components of the twin pulses is presently fixed at 12 microseconds on all air-ground channels and on all ground-air channels. Hence, the ground and air equipments employ a twin pulse encoder and a twin pulse decoder of fixed setting.

2.5 R-F CHANNEL CONSIDERATIONS.

In assigning frequencies to clear channel, crystal-controlled navigational stations, the normal rule followed is the one applicable to most radio systems -- broadcast, television, mobile, point-to-point, etc. That is, the identical frequency is not assigned to two ground stations within likely interference range of each other. For Tacan type DME, this distance would be of the order of 400 miles, dependent somewhat on aircraft altitude that would provide line-of-sight considerations. Beyond that conventional restriction, any frequency, adjacent or far-removed, may be assigned with complete safety to any DME station, close by or far removed.

DME has an important advantage in the matter of co-channel interference. This advantage arises from the fact that, because of its use of low-duty-cycle pulse transmissions, the signals from two stations on the same radio frequency will interleave, but not add. Thus, only the stronger of the two will have any effect on the receiver, the weaker being almost totally rejected. The net result is that the airborne equipment will display the correct, accurate distance (and bearing, in Tacan) to the nearer of the two stations. In CW systems, such as VOR, on the other hand, even a relatively weak interfering signal, while not taking complete control, may introduce large errors. This resistance to co-channel interference, in DME or Tacan, eases the problem of area-wide channel allocations considerably. Thus, in allocating Vortac and VOR/DME channels, only the VOR performance need be taken into account.

2.6 CONSTANT DUTY CYCLE OPERATION.

A consideration of ground station operation is to maintain its receiver sensitivity at the maximum level without having the associated transmitter continually triggered by noise. A very satisfactory solution is for it to operate on the "constant-duty-cycle" principle. In this method of operation, the ground station receiver is provided with an automatic gain control (AGC) system which maintains the number of pulses out of the receiver at an almost constant value, about 2700 pulses per second.

Thus, a few interrogations are being received, the gain of the receiver automatically increases, adding noise-generated or "squitter" (or "filler") pulses until the requisite total number is obtained. If several more aircraft come within range, the receiver gain drops slightly and some noise-generated "filler pulses" are replaced by DME reply pulses. The relationship between gain and number of pulses is such that only a 3 db change in sensitivity occurs between the reception of one aircraft and the reception of 100 aircraft.

A further advantage of this type of operation is that the airborne receiver automatic gain control circuits are allowed to operate as if 100 aircraft were present all the time. Since the equipments are designed for this purpose, no adverse effects due to variations in actual traffic conditions can occur.

Since a ground station transmits a maximum rate of 2700 pulses per second even if 100 aircraft are interrogating, it follows that in heavy traffic the aircraft may not receive 100 percent replies to their interrogations. The situation is as follows: The standard statistical assumption specified for DME system operation is that, on the average, among all aircraft interrogating at any given time, 95 percent of them will be track and 5 percent of them will be in search. Under this assumption, the interrogation rate for 100 aircraft would be 24 pps x 95 aircraft plus 150 pps x 5 aircraft, or a total of 3080 interrogations per second. If 2700 replies per second are returned to the 3080 interrogations per second, the ratio of replies to interrogations is 90 percent. However, the airborne DME should operate effectively with a reply ratio at least as low as 50 percent, that is, 15 replies per second compared to 30 interrogations; or 1500 replies per second for 100 aircraft. Hence, an actual reply rate of 2700 replies per second to the interrogations transmitted under specified maximum traffic conditions constitutes a safe margin of operation.

Furthermore, consider the extreme case in which 100 aircraft are present and the ground beacon has temporarily failed. In such a case all aircraft will automatically go into "search", increasing their pulse interrogation rate to 150 pairs of pulses per second. When the ground beacon returns to normal service, it will be suddenly confronted by 15,000 pulse-pairs per second. Its receiver gain will automatically reduce until only the 2700 strongest interrogations are replied to. This provides immediate resumption of service to the 18 aircraft that are nearest to the beacon. Their interrogation rates consequently drop from 150 to 24 per second, relieving the beacon of some 1200 interrogations and allowing it now to increase its sensitivity and hence reply to aircraft some further distance away. Within a minute or two, almost all aircraft are back in the "track" condition, with a total of less than 3000 interrogations.

An important system consideration in connection with this method of operation is that one should always strive for a condition whereby the beacon-to-aircraft transmission is stronger than the aircraft-to-beacon transmission. That is, for equal receiver sensitivities, ground beacon power should be greater than airborne interrogator power. Thus, regardless of aircraft location, each interrogation is answered by a reply which is always of useable strength, leading to proper operation of the airborne tracking circuits, with consequent minimum total traffic interrogation rate to the ground beacon. The ground beacon consequently is not exposed to and burdened by useless interrogations.

SECTION III

Circuit Theory

3.1 RECEIVER/TRANSMITTER.

3.1.1 R-F SECTION.

The generation of the transmitted R-F pulses and the conversion of received R-F pulses to the I-F frequency of 63 mc is accomplished by the R-F unit.

3.1.2 FREQUENCY GENERATION

One hundred different transmitter output frequencies, corresponding to VHF/VOR channels from 108.0 to 117.9 mc, may be generated by summing one of eleven "mc" crystal frequencies and one of ten "tenth mc" crystal frequencies in a mixer. This mixer output frequency is multiplied by a factor of twelve by a doubler, tripler, and final doubler to produce the UHF frequency that will be received by the DME Ground Station.

The triode, V-106A, is the high frequency oscillator, the eleven high frequency crystals range from 66.802 to 75.135 mc. A transistor, Q-101, is the low frequency oscillator. The ten crystals are from 19.948 to 20.698 mc. Q-101 is powered directly from the aircraft's dc bus for 14 volt operation or from a 14 volt tap on the heater string when installed for 28 volt operation.

Outputs from both oscillators are coupled to the control grid of the pentode mixer, V-106B. The plate circuit of V-106B is tuned to the mixed sum of the two oscillators. These frequencies range from about 87 to 96 mc. The mixer output is fed to a tuned pentode amplifier, V-105, that raises the R-F power to the level required by the next stage. The selectivity of V-105's tuned plate circuit also eliminates any undesired frequencies generated in V-106B.

V-104 is a pentode doubler, with the amplified 87 to 96 mc energy on the control grid, and 174 to 196 mc output. V-104's plate is shut-fed, with plate voltage supplied through an R-F choke, L-115. The push-pull tuned circuit to the grids of the tripler, V-103, also serves as the plate circuit of V-104.

V-103, a dual pentode, with its grids receiving drive power in the frequency range from 174 to 192 mc, triples the frequency to produce an output at 521 to 575 mc. The push-pull plate circuit is link-coupled to the cathode of the final doubler, V-101.

V-101, the final doubler, is a "pencil" type triode designed for efficient operation in cathode-driven UHF service. Its plate circuit may be thought of as a half-wave transmission line with the length of L-131 shortened from a full half-wave length by the capacitive loading of the tube's output capacitance on one end and the capacitance of the tuning capacitor and antenna coupling circuit on the other end. Final plate power is applied to the point on the line at which R-F voltage is minimum.

In later units, serial number 1600 and up, V-101 is a ceramic planar triode that is very rugged mechanically and provides more power gain than the "pencil" tube formerly used. These later units may be readily identified by the cylindrical cathode cavity containing V-101. C-142 is tapped on the tripler plate circuit and connects to the inner conductor of a small coaxial cable, N-102. The other end of N-102 connects to the cathode cavity ground and feed thru terminals. See Figure 5-2A.

V-101's cathode cavity is designed to have a broad tuning response at the tripler output frequencies, 520.5 to 575 MHz. In the event that transmitter realignment is indicated, the cavity may be adjusted to increase the transmitter's output over a portion of its frequency range, if necessary. This procedure is outlined in Section 5.4.6.

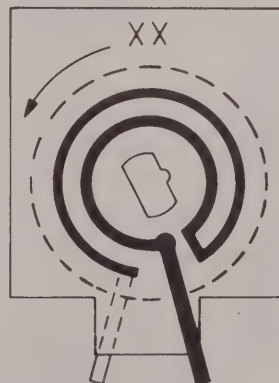


Figure 3-1. Variable Inductor

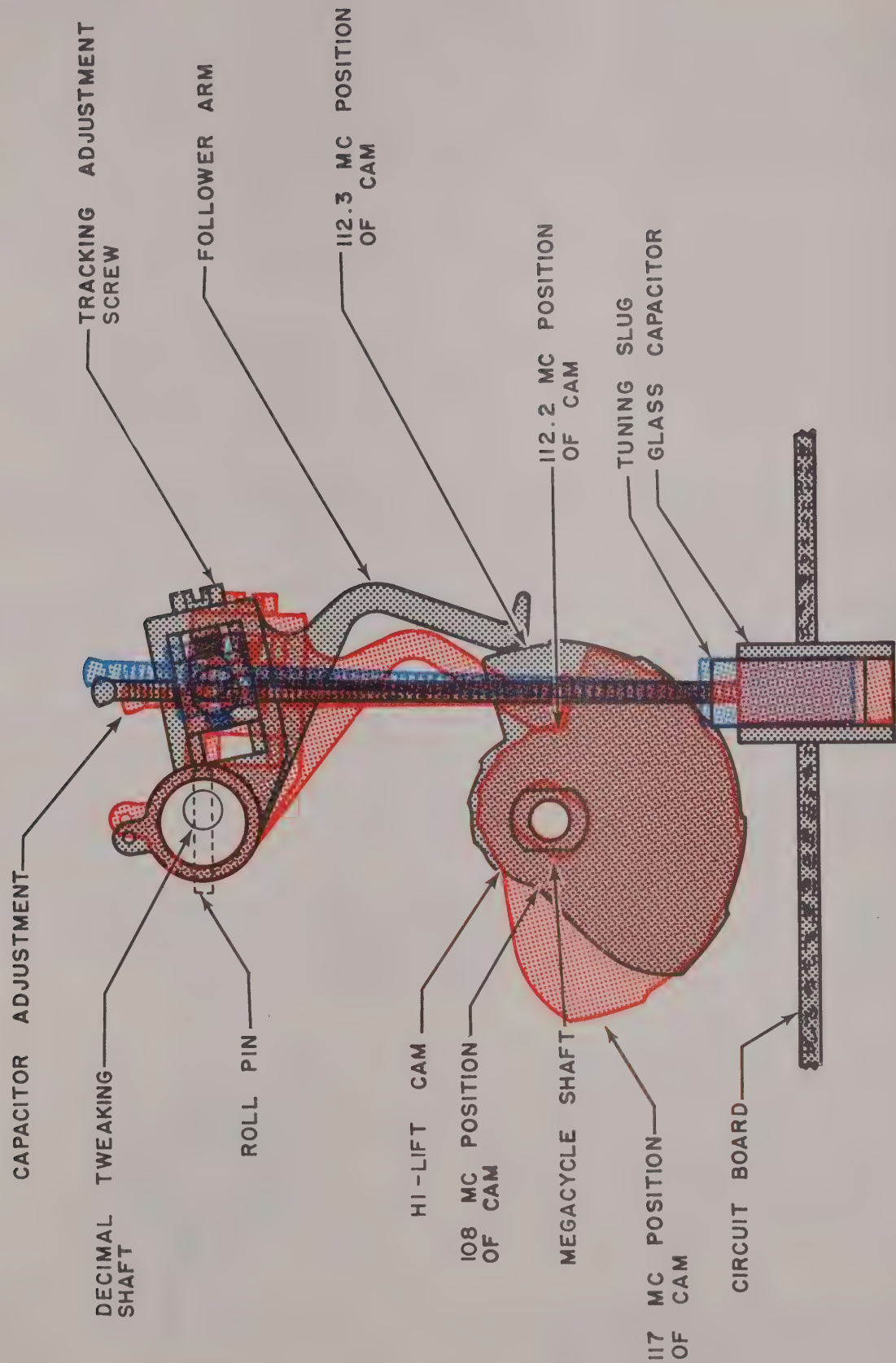


Figure 3-2. R-F Preselector Adjustments

3.1.3 FREQUENCY TRACKING.

All tuned circuits that change frequency with changes in channel frequency are tracked except the low frequency oscillator itself. Four variable indicators track the high frequency oscillator V-106A, mixer V-106B, amplifier V-105, and tripler grids of V-103. The variable inductors are ganged to a megacycle selector shaft that has eleven positions, one for each high frequency crystal. Thus, these circuits are tracked for each change in the high frequency oscillator, but not for low frequency oscillator changes. These circuits are trimmed during alignment at ".5 mc" frequencies to minimize degrading of power at the ".0 mc" and ".9 mc" channels.

These variable inductors may be visualized as a hairpin bent into a circle. As the channel frequency is increased, the inductors are rotated so that their effective length is reduced. This lowers their inductance and raises the resonant frequency of their associated circuits to correspond to the frequency change. At the "117 mc" position, the variable inductors are at their position of minimum inductance and most of the circuit's inductance is in the series tracking indicators. A simplified drawing of the variable inductors is shown in Figure 3-1.

Remaining circuits to be tracked include the push-pull plate circuit of V-103, output circuit of the final doubler, V-101, and the three receiver preselector tuned circuits. These are tracked by variable glass capacitors that consist of a glass tube with two thin sleeves of metal on the outside. One sleeve is soldered to the circuit board that is used as ground and the other sleeve is connected to the circuit to be tuned. A metal tuning slug, whose position is determined by a nylon cam and adjustable cam follower assembly, slides up and down inside the glass tube. The slug varies the capacitance between the two sleeves, thereby changing the frequency of the tuned circuits. See Figure 3-2.

A slightly different arrangement is used at C-139 in the V-103 tripler plate circuit. This capacitor is in a circuit that is balanced with respect to ground, so a split stator type is required. A sleeve at one end is separated along the axis of the glass tube. With each plate of V-103 connected to each side of this split sleeve, the tuning slug is used to vary plate-to-plate capacitance rather than capacitance to ground.

A versatile arrangement in the cam follower assemblies provides an adjustment of amount of capacitance change required for tracking. The capacitor adjustment screws connected to the tuning slugs are adjusted manually to tune up on the "117.5 mc" position. Tracking adjustment screws vary the amount of swing in the capacitor adjustment screws with changes in cam position by moving the capacitor adjustment screws in or out on the cam followers. By moving further out from the rotational axis of the cam follower, more change in capacitance is realized for each step of the cam. Tracking screw adjustments are made at "108.5 mc". Some interaction between the capacitor adjustment screws and the tracking screws may be noted. When these circuits are peaked alternately on "108.5 mc" and "117.5 mc" channels, the cam steps insure tracking for all other channels.

An additional refinement makes small changes in the tuning of the glass capacitors for changes of the low frequency oscillator. The low frequency oscillator crystal turret is turned by a shaft concentric to the megacycle selector shaft, called the kilocycle selector. A cam on the crystal turret causes a small eccentric rotation of the cam follower arm support shaft, which transmits a small change to the tuning slugs. With the kilocycle selector in the ".5 mc" position, the roll pin through the cam follower arm support shaft and the kilocycle tweaking shaft must be in a horizontal plane.

3.1.4 RECEIVER PRESELECTOR.

DME channels are allocated such that the airborne transmitting frequency is always 63 mc away from the airborne receiving frequency. On DME channels corresponding to VOR frequencies of 108.0 to 112.2 mc, the airborne receiver's frequency is below the airborne transmitter's frequency. With VOR frequencies of 112.3 to 117.9 mc, the received DME frequency is above the transmitted frequency. This requires that, when changing from a VOR frequency of 112.2 mc to 112.3 mc, the receiver preselector tuned circuits must make a jump in frequency of 137 mc. This is accomplished by a large step in the cams that tune the preselector glass capacitors.

The three receiver preselector tuned circuits provide two useful functions. They prevent passage of other than desired frequency signals, such as from other services operating in the UHF spectrum, channel three TV which would fall in the 63 mc I-F, and other airborne DME's which could appear as an image response. They also prevent loss of transmitter power into the receiver, which would result in a drop in useful transmitter output and destruction of the mixer diode. Although both the receiver and transmitter portions of the R-F unit are coupled to a common antenna, high selectivity of all tuned circuits precludes loss of one's energy to the other.

Selection of VOR frequencies from 108.0 to 112.2 mc result in selection of DME preselector frequencies from 978 to 1020 mc, and 112.3 to 117.9 mc correspond to 1157 to 1213 mc. Preselector tuned circuits are tracked as discussed under FREQUENCY TRACKING.

Each preselector tuned circuit is in its own shielded compartment. Inductive coupling between circuits is accomplished by taps on the inductors that are fed through small holes in the shields.

3.1.5 TRANSMITTER R-F LEVELS.

Since the airborne transmitter is always 63 mc above or below the received frequency, depending on what particular channel is in use, it conveniently follows that the same frequency that we radiate qualifies for use as local injection for our receiver mixer. This results in an I-F of 63 mc.

R-F power required for the receiver mixer is, of course, much less than full transmitting power. Thus, while the high frequency oscillator and mixer, V-106A and B, run at the same power level for both functions, later stages of the transmitter run at a low level while supplying mixer injection and then are

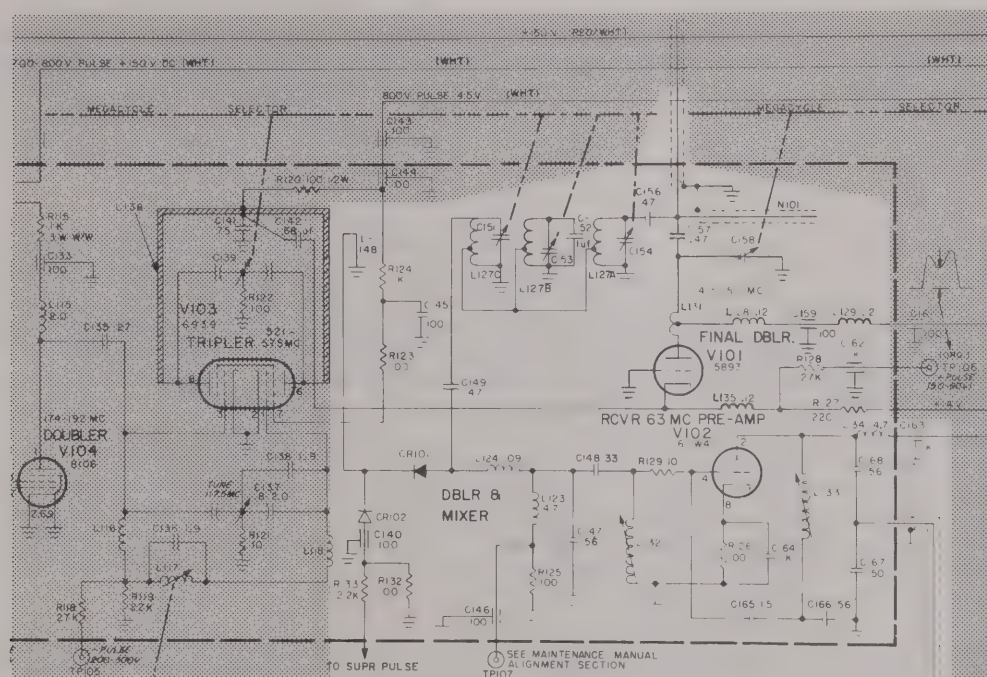


Figure 3-3. Receiver R-F Section

pulsed to a much higher level during the short times of R-F pulse transmission. V-105 and V-104 are supplied with about 150 volts and V-103 runs about 45 volts during the time only a mixer injection power level is required.

At R-F pulse transmission times an 800 volt positive pulse of 20 microsecond duration is superimposed on these dc voltages to generate a high R-F drive level fed to the cathode of the final doubler, V-101. The final doubler receives plate power in the form of a pair of positive high voltage pulses of 3.5 micro-seconds width and 12 microsecond spacing between their leading edges. These 1400 to 1800 volt pulses are timed so as to occur at the instant transmitted R-F energy is desired. At all other times the plate voltage of V-101 is zero. A small amount of R-F energy at half the transmitter output frequency is generated at V-103 for receiver mixer injection. Since V-101's cathode is also coupled to V-103, it has a 14 volt back-bias voltage to eliminate the possibility of any R-F energy being fed through V-101 and radiated during receiving periods. High R-F drive power from V-103 during R-F pulse transmissions easily overcomes this back-bias to drive V-101 into heavy conduction.

Several test points in the R-F unit allow convenient circuit monitoring. Rectified grid drive voltage test points provide a measure of the previous stage's performance and alignment. Checking for mixer crystal current at TP-107 gives a quick check of the entire R-F drive chain. Best transmitter performance is obtained by peaking test points under pulsed conditions with a scope rather than using a voltmeter to peak at lower unpulsed level.

3.1.6 RECEIVER MIXER.

After passing through the receiver preselector tuned circuits, received R-F pulses from the DME ground station are sent to a silicon point-contact mixer diode, CR-101. Pickup loop L-148, near the plate line of tripler V-103, supplies CR-101 with R-F energy at half the required mixer injection frequency. CR-101 doubles this 520.5 to 575 mc drive and at the same time mixes the resulting 1041 to 1150 mc with signals from the preselector. The difference frequency, 63 mc, is coupled to V-102, the I-F preamplifier. TP-107 provides a test point to measure the dc component resulting from rectification of mixer drive. Less than 100 microamperes results in unsatisfactory receiver performance.

V-103's output level is many times higher when pulsed for transmission, so drive to CR-101 could approach damaging levels at these times. CR-102 is connected across L-148 to short out drive to CR-101 when V-103 is pulsed. A positive pulse from the suppressor pulse output of the pulse modulator is applied to CR-102's anode. This reduces CR-102's resistance to a very low value and effectively shorts

out L-148 with bypass capacitor C-140. When a transponder is installed, the suppressor output will also disable the DME receiver during transponder pulse transmissions. The transponder transmitter frequency is within the DME frequencies (1020 to 1156 mc), so inhibiting the DME receiver at these times removes an interference threat.

In later units, CR-102 is a silicon PIN diode, specially designed to short circuit RF energy when driven into conduction. CR-102 has better reliability in this application and improves reliability of CR-101 by providing increased attenuation of mixer drive during transmitter pulse periods. In these same units, trimmer C-169 shunted by C-170 broadly resonates the pickup loop, L-148 at the 520.5 to 575 MHz drive frequencies. C-169 may be adjusted to equalize mixer injection at the 108.0 and 117.9 MHz channels, with a rise in injection noted towards the middle channels.

On these later units, mixer injection voltage monitored at TP-107 should be a minimum of -0.2 volts DC and a maximum of -0.8 volts DC on any channel. When the transmitter is pulsing, the maximum voltage should be around -2.0 volts as seen on a scope. Mixer injection may be adjusted by moving pickup loop L-148 in relation to the tripler plate circuit.

3.1.7 I-F PREAMPLIFIER.

63 mc output from CR-101 is amplified before leaving the R-F unit by V-102, and I-F nuvistor tube pre-amplifier. Tuned circuits in both grid and plate use slug tuned coils for alignment adjustment. C-147 and C-148 form an impedance matching network between CR-101 and V-102. C-167 and C-168 similarly match V-102 to the I-F amplifier input. C-165 provides neutralization feedback from the plate circuit to the grid.

3.2 I-F SECTION.

The I-F section receives pairs of 63 mc pulses from the I-F preamplifier in the R-F unit. A single decoded video output pulse results for each properly coded pair of input I-F pulses. The I-F section performs three primary tasks; amplification of pulses of proper frequency, rejection of off-frequency pulses and the generation of one dc output pulse for each pair of properly spaced received pulses. Since there is no gain in the receiver at the VHF DME channel frequencies, all receiver gain must be developed at I-F frequencies.

3.2.1 63 MC AMPLIFIER.

Q-301, the input transistor of the I-F section, amplifies the 63 mc pulses. Q-301's gain is controlled by an AGC voltage applied to the emitter. A thermistor in the base biasing network minimizes gain variations with temperature changes. R-346, the gain adjustment pot, also determines Q-301's collector current to set the overall gain of the I-F section.

Frequency selectivity sufficient to reject an adjacent DME channel one megacycle away is difficult to achieve at an I-F frequency of 63 mc. Adequate rejection is realized by mixing the first I-F frequency of 63 mc with a local oscillator frequency of 71.47 mc to obtain a second, lower I-F frequency at 8.47 mc. Tuned circuits at 8.47 mc provide the required selectivity.

3.2.2 OSCILLATOR.

A 71.47 mc voltage is generated by a transistor crystal oscillator, Q-303. The base of Q-303 is grounded for R-F frequencies by C-306. Normal operation is indicated by dc base voltage of not more than about 0.6 volts, measured with a VTVM at TP-305. The position of fixed inductor L-310 with respect to ground has a definite tuning effect. Proper positioning of L-310 is determined by moving it slightly with a plastic or fiber tool until a dc voltage minimum is indicated at TP-305.

3.2.3 MIXER.

71.47 mc output from Q-303 is applied to the emitter of mixer transistor Q-302. 63 mc pulses from Q-301's collector tuned circuit to the base of Q-302 result in pulses of 8.47 mc, the difference frequency, in Q-302's collector tuned circuit. Conversion gain is realized in Q-302, with its 8.47 mc output considerably greater than its 63 mc input.

3.2.4 8.47 MC AMPLIFIER.

Q-304, Q-305, and Q-306 are 8.47 mc I-F amplifier stages that provide most of the receiver gain and selectivity. T-302 and T-305 are stagger-tuned to provide the required I-F bandwidth. AGC voltage to the emitters of Q-304 and Q-305 controls their gain with variations in received signal level. These transistors are reverse biased to decrease their gain, as opposed to Q-301, which is forward biased for decreasing gain. CR-301 across T-304's winding is normally not conducting. When channeling to a very close DME ground station, high signal levels can cause saturation of Q-305 or Q-306 due to time constant delays in the AGC circuit. During this brief interval, CR-301 will have enough I-F voltage imposed so as to cause conduction and limit drive to Q-305 and Q-306 below saturation levels.

3.2.5 DETECTOR AND ALIGNMENT.

Detection of 8.47 mc pulses and amplification of the resulting dc pulses occur in Q-307. At TP-302, two pulses may be observed for each 63 mc pulse pair at the I-F input jack, J-411. A dc voltmeter, negative lead grounded, is used at TP-302 to indicate alignment adjustments with a 63 mc CW signal applied to J-411. The 63 mc signal generator may be connected directly to J-411 through a coax cable with appropriate connectors if the attenuator output circuit is an open circuit for dc, as in the Hewlett-Packard 608 series. If the signal generator's output circuit has dc continuity, a blocking capacitor such as a .001 mfd or larger disc capacitor must be connected in series with the test cables inner coax con-

ductor. Failure to observe this precaution will result in shorting out Q-301's base bias network, reducing Q-301's gain to less than zero.

During I-F section alignment, the 63 mc CW signal generator output must be kept low to prevent overloading. This will be insured if the voltage at TP-302 is maintained at less than about half a volt. Oscillator operation, as discussed previously, should be checked first. T-301, T-304, and T-306 are peaked with the generator on 63.0 mc. T-302 is peaked at a generator frequency of 63.1 mc and T-305 at 62.9 mc for stagger tuning.

3.2.6 DECODER.

Development of a single negative pulse for each properly spaced pair of received pulses and inhibiting of receiver output pulses at DME or transponder R-F pulse transmission intervals occurs in the decoder, Q-308 and Q-309. No decoder output can be generated by meaningless signals, such as CW or pulses with other than the required 12 microsecond spacing. Since Q-308 and Q-309 have their collector-emitter circuits in series, both must receive positive base drive at the same time to provide a current path between ground and R-329. Positive pulse pairs with 12 microsecond spacing from detector Q-307 are presented to Q-309's base with no delay, but DL-301 causes a 12 microsecond delay in the pulse pair's arrival at Q-308's base. Therefore, the first pulse turns on Q-309 but since the first pulse must travel through DL-301 to reach Q-308's base, Q-308 is not yet turned on and no current can flow through R-329. If the pulse spacing of the received pulse pair matches the delay through DL-301, the second pulse of the pair will turn on Q-309 at the same instant that the first pulse, delayed by DL-301, turns on Q-308. Under these conditions, with Q-308 and Q-309 turned on simultaneously, the voltage at R-329 drops to form a negative pulse. 12 microseconds later, the second pulse will arrive at Q-308, but since at this time there is no pulse drive at Q-309, no decoder pulse is generated.

3.2.7 PULSE BLANK.

Q-313, the pulse blank transistor, disables the decoder by shorting out base drive to Q-309. A positive pulse from the suppressor pulse output of the pulse modulator from a transponder, if connected, will turn on Q-313, causing its collector to emitter resistance to drop to a very low value. This prevents meaningless outputs by the I-F section at DME or transponder R-F pulse transmission times. When Q-313's base is not driven, its collector-emitter resistance is extremely high and has no effect on normal decoder performance.

3.2.8 PULSE AMPLIFIER.

Pulse amplifier Q-310 receives the negative decoder output pulses as base drive. These drive Q-310, a PNP germanium transistor, into saturation so that the voltage at the output test point, TP-303, approaches the +20 volt supply voltage for the duration of the decoder pulse. This is the decoded receiver output pulse that is supplied to the Video Section.

3.2.9 AUTOMATIC GAIN CONTROL.

Automatic Gain Control Voltage is developed from negative decoder output pulses. C-324 is initially charged to +20 volts, with the base of Q-311 at ground when no signals are being received. When decoders Q-308 and Q-309 are both gated on by a received pulse pair, C-324 partially discharges through CR-302, Q-308, and Q-309. As Q-308's collector voltage rises back toward 20 volts, the base of Q-311 rises to some positive value due to the long charging time of C-324 through R-342. Q-311, an emitter-follower, transfers this base voltage increase to its emitter, thereby placing a positive charge on the long time constant filter network in the base circuit of Q-312.

Q-312's collector to emitter resistance drops with the emitter, TP-304, becoming more positive. Q-312's collector, connected to Q-301's emitter circuit, becomes less positive which results in Q-301's collector current increasing. Q-301's collector current vs gain characteristics are such that a current increase results in a gain reduction. Q-304 and Q-305, whose emitters are returned to ground through TP-304, decrease in gain with reduction of their collector currents caused by more positive emitter bias.

The net results of gain reduction is that the detector output pulses fed to the decoder bases are of such a level that the decoders are not driven near saturation and an increase in signal level will result in a larger negative pulse at the decoder output. The positive going trailing edge, having a wider excursion, results in more change in C-324's charge. This increases the AGC level, reduces I-F gain accordingly, and the system rapidly approaches equilibrium at the higher signal level. A decrease in signal level causes less change in C-324 for each decoder pulse and an increase in charge through R-342. C-322 and C-323 partially discharge through R-339, resulting in less drive to Q-312 and lowered AGC action.

TP-304 provides a convenient point for monitoring AGC performance and determining that a pulsed signal generator is centered on the DME channel frequency. Voltage readings at TP-304 range from about 0.15 volts with no signal to about 2.25 volts at high (about - 10 dbm) signal levels.

3.3 PULSE MODULATOR SECTION.

The primary function of the pulse modulator is to furnish short, high energy pulses to the DME transmitter. Pulse wave forms from the modulator are also used to disable the DME receiver and a transponder, if installed on the aircraft, during the instant of pulse transmission by the airborne DME. The dropping resistor, R-206, which is in the plate circuit of the I-F preamplifier, V-102, is also located on the pulse modulator chassis, but has no relation to the modulator circuitry.

Silicon controlled rectifiers are solid-state equivalents of gas-filled thyatrons. When the gate terminal, corresponding to the grid of a thyatron, is made positive with respect to the cathode by a volt or so, the anode to cathode resistance drops to an extremely low value. This low resistance path allows the flow of the large current required to develop high energy pulses. Once the SCR starts to conduct, it will continue to do so even though the signal applied to the gate terminal has ended, until the current flow between the cathode and anode has been reduced to a very low value. At this time, the SCR "turn off" with the anode to cathode resistance becoming very high until the next positive gate signal is applied.

3.3.1 OUTPUT WAVE FORMS.

Three different pulse wave forms are generated by the pulse modulator. One wave form has about 20 microseconds duration with a peak voltage of approximately +800 volts. This wave form is supplied to driver stages in the transmitter at pulse transmission times. The second wave form has the same shape and time of occurrence as the first, but the amplitude is approximately + 80 volts. It is used to control certain DME receiver and transponder functions as noted above. The third wave form consists of a pair of positive + 1800 volt pulses, 3.5 microseconds wide with 12 microseconds spacing between their leading edges at the 50% point. This wave form occurs simultaneously with the 20 microsecond pulse and is applied to the plate of the final doubler, V-101 in the R-F unit. All these pulse wave forms reoccur at a rate of 150 per second in search and 30 per second in track when triggered by a signal from the initiation board. Since all modulator wave forms are derived from unregulated power supply voltages, their voltages will follow variations in primary power applied to the DME.

3.3.2 20 MICROSECOND PULSE.

The 20 microsecond pulses are generated by the discharge of a pulse forming network consisting of C-205 through C-209 and tapped inductor L-201. C-205 through C-209 are charged to 200 volts through CR-202 and R-1209. When SCR-201 is triggered into conduction by a pulse from the initiation board, the energy stored in C-205 through C-209 in conjunction with the tapped inductor, L-201, discharges through the primary of T-201. Transformer T-201's secondary windings are so phased that the negative wave form imposed on the primary becomes positive with respect to ground on the secondaries.

The +150 volts applied to V-103, V-104 and V-105 in the R-F unit must pass through one of the secondaries of T-201. With the low end of this winding well bypassed, when a 20 microsecond pulse occurs, this 800 volt pulse is added to the normal voltage to generate a higher power 20 microsecond R-F driving pulse to the cathode of V-101. Since V-103 requires only +45 volts at other than pulse transmission times, R-202 drops the +150 volts to +45 volts. C-202, shunting R-202, allows the full pulse voltage to be applied to V-103 with no loss in voltage through R-202. CR-201 and CR-206 short out the negative swing across T-201's secondary caused by the collapsing magnetic field at the end of the pulse.

Suppressor pulses from the other secondary winding of T-201 pass through CR-205 to J-404 on the front panel, the I-F section and the R-F unit. R-201 provides a dc voltage return for the suppressor line. CR-205 prevents positive DME suppressor pulses from a transponder from being shunted across the low impedance of T-201's secondary. The pulse output at J-404 provides a handy scope synchronizer source to observe wave forms recurring at pulse repetition rates.

3.3.3 3.5 MICROSECOND PULSES.

Charging current for C-214 also flows through R-1209 and CR-1206 in the power supply. When SCR-201 conducts, the positively charged end of C-214 is grounded through CR-202 and SCR-201. This places a negative voltage on the 3.5 microsecond pulse forming network between C-214 and T-202. The step-up ratio and phase inversion of T-202 transforms the negative 200 volt primary pulse to an 1800 volt positive pulse on the secondary. CR-204 prevents T-202's primary from swinging positive at the end of the pulse.

As mentioned previously, two 3.5 microsecond high voltage pulse outputs are required from the pulse

modulator to develop the double pulse of transmitter output power for each trigger pulse from the initiation board. The second 3.5 microsecond pulse is generated by C-213 and C-215, SCR-202 and the delaying triggering circuit to the gate of SCR-202. C-213 and C-215 are charged to + 200 volts through R-1208 and CR-1205 in the power supply. C-210, connected between the anode of SCR-201 and the other components of SCR-202's gate trigger network, is charged to + 200 volts. At the time SCR-201 conducts, C-210's positive end is instantly brought to ground, putting a high negative voltage at the top of L-202. See figure 3-4.

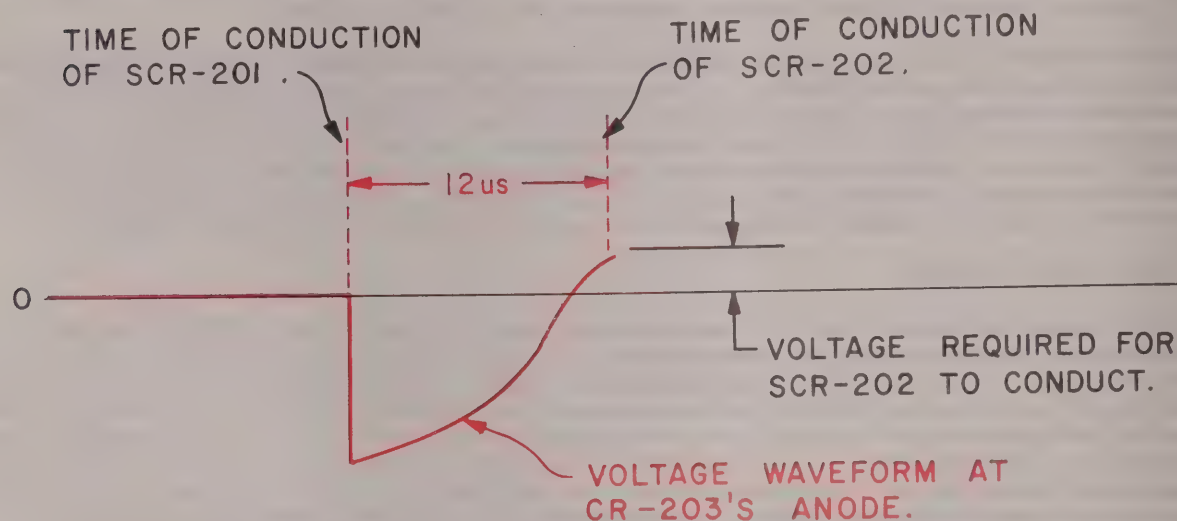


Figure 3-4. Pulse Spacing Wave Form

Since C-201, C-211 and L-202 form a resonant circuit adjustable to around 20 kilocycles, this combination starts to oscillate, swinging in a positive direction. CR-203 is back-biased, allowing no conduction to SCR-202's gate until the oscillating voltage swings positive with respect to ground, approximately a quarter cycle or 12 microseconds later. With CR-203 now forward biased, the voltage between gate of SCR-202 and ground quickly rises to a value that causes SCR-202 to conduct. Energy stored in C-213 and C-215 is shaped by the 3.5 microsecond pulse forming network to produce the second pulse output from T-202.

3.3.4 POWER SUPPLY PROVISIONS.

R-1209 has a lower resistance than R-1208 because it must carry charging current from both the 20 microsecond pulse forming network and C-214 to generate the first 3.5 microsecond pulse, while R-1208 carries only charging current to C-1213 and C-1215 to generate the second 3.5 microsecond pulse. When SCR-201 conducts, it tends to drain some of the charge from the second 3.5 microsecond energy storage capacitors, C-214 and C-215. Since C-213 and C-215 in parallel are larger than C-214, this slight loss of charge is compensated for and the two 3.5 microsecond pulse outputs are equal or nearly so.

The two + 200 volt diodes in the power supply, CR-1205 and CR-1206, have no filter capacitance from their cathodes to ground. This insures that SCR-201 and SCR-202 will return to a non-conductive state after their respective networks are discharged. Terminals 1 and 4 of T-1201 in the power supply are alternately at + 200 and - 200 volts. At the time that CR-1205 and CR-1206 anodes are negative, no current can flow through CR-1208 and R-1209. This allows a complete half-cycle at the power supply switching frequency for SCR-201 and SCR-202 to revert to their nonconducting state.

3.4 VIDEO SECTION.

The video section consists of the six printed circuit plug-in boards and the associated interwiring between boards. All the logical decisions involving searching or tracking a ground station are made in this section. When servicing or analyzing the circuitry, it is convenient to functionally isolate the video section from the rest of the DME, as shown in Figure 3-5.

Note that the only information required by the video section is decoded video. These are single pluses representing both replies and "squitter" (random pulse pairs initiated by the ground station to maintain AGC operation in the airborne receiver) from the ground station. Note also that the transmitter modu-

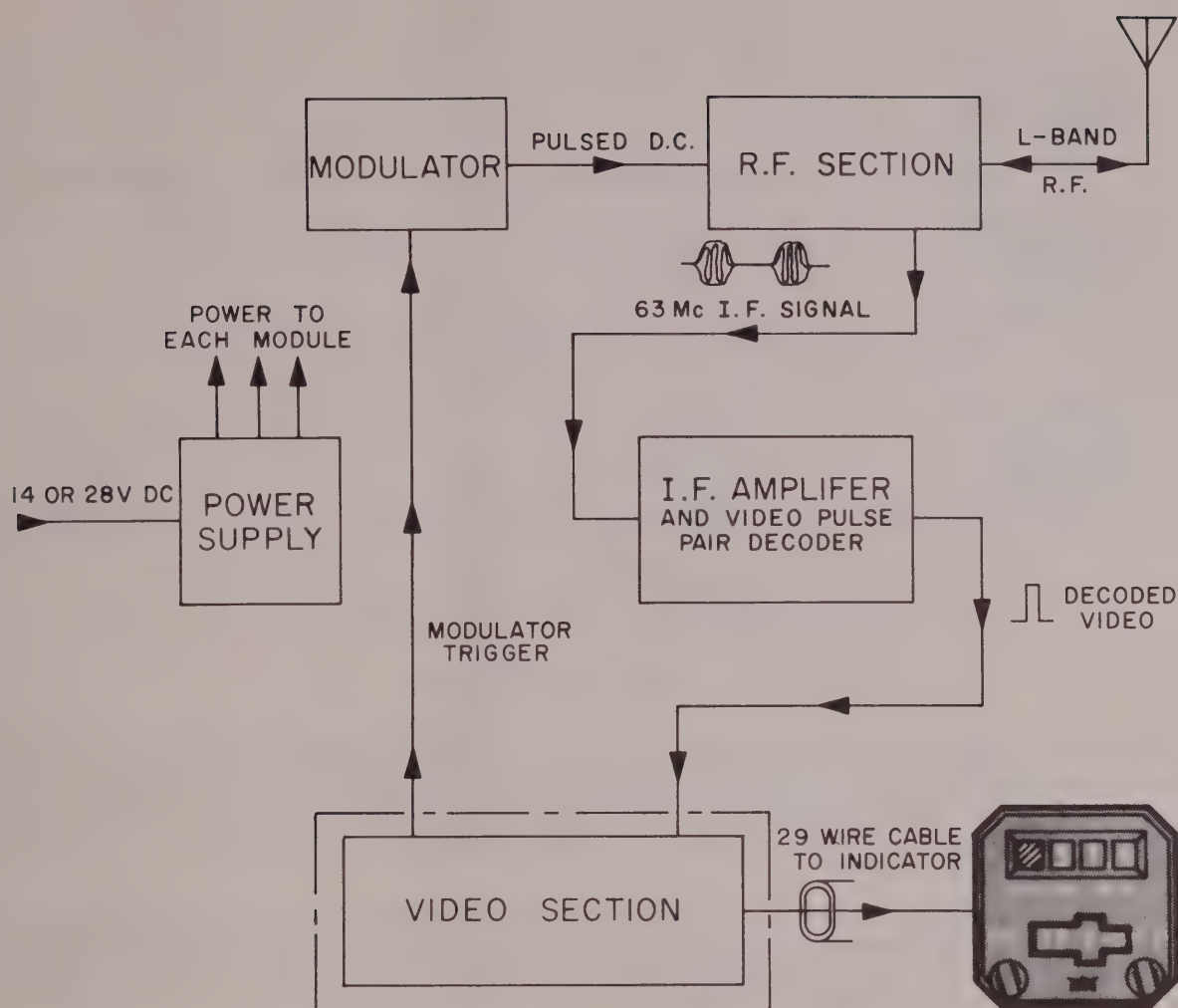


Figure 3-5. Block Diagram

lator is slaved or commanded to fire by the video section.

The function of the video section is to measure the time interval between the interrogation of the ground station by the DME and the reception of a valid return from the ground station. It then presents to the pilot a distance in nautical miles, determined by the propagation time of a radio wave on this round trip path. Due to the fact that the ground station is replying to other aircraft in the area, and is also producing "squitter" as previously mentioned, it is not immediately evident to the DME which replies are answers to its interrogations and which are meaningless. Thus, the video section must "search" for a point in time, occurring after each interrogation, at which returns fall consistently.

When in the search mode of operation, the DME interrogates at a rate of approximately 145 times per second. The interrogation is done randomly with an average rate of 145. However, from one interrogation to the next, there may be as much as a 20% departure from this rate as the prf generator is deliberately noise modulated in the initiation section. This process will be explained in a later discussion. During search, the video section makes a trial solution of distance (time) and compares the returns for agreement in time (distance) with this trial number, as shown in Figure 3-6.

If no retrun falls within the boundry or limits of the trial solution, the video section advances the trial solution by 0.2 nautical miles at the end of that cycle, (before the next interrogation). Since each round trip tenth nautical mile (at the speed of light or a radio wave through space) corresponds to a propagation time of 1.2364 microseconds, a new trial solution or time of marker, will be produced in the video section 2×1.2364 microseconds, or about 2.5 microseconds later than on the previous cycle.

If, during any interrogation cycle, a received return falls within the limits of the trial solution, the unit holds the stored trial number and waits at that same time for the next several interrogation cycles. If a

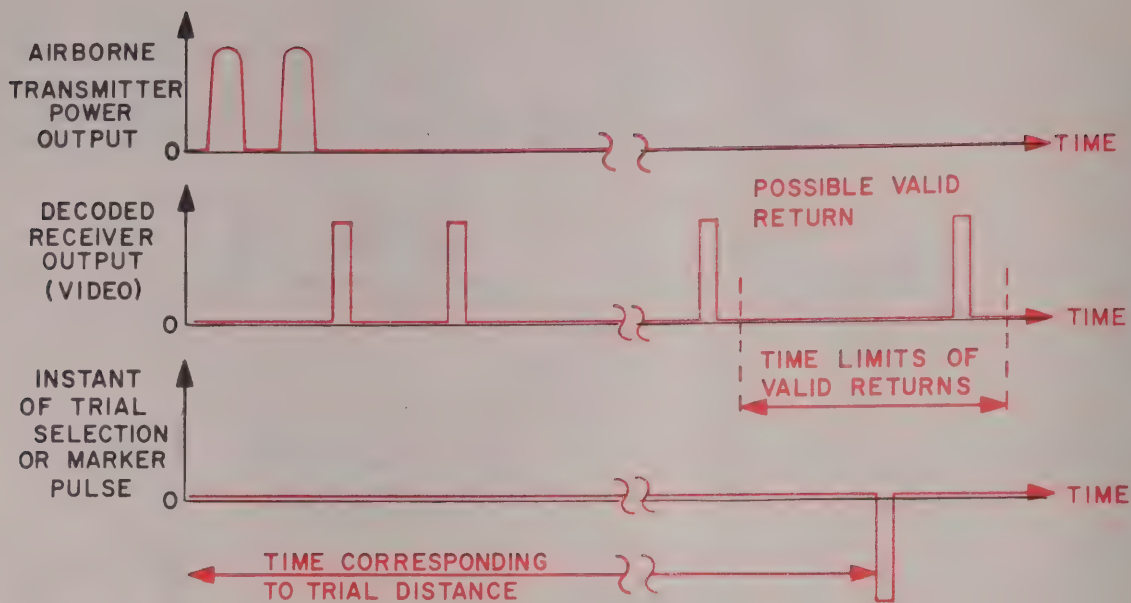


Figure 3-6. Search Cycle Wave Form

return falls consistently in this time zone for six cycles or so (depending on the percentage return) the return is identified as a valid one and the unit stops the search and goes into what is known as the "track" mode. If the return was not consistent, the unit considers it to have been random or not meaningful with its own interrogation. The unit then continues to search out in distance for a time zone of correlation between interrogation and reply.

The accuracy determining element for all timing functions is a crystal oscillator or "clock" on the initiation board running at a frequency of 1.617 megacycles per second. The oscillator output is divided by two, by a binary or "flip-flop" to a frequency of 808.78 kilocycles, the time per cycle then corresponding to a period of 0.1 round trip nautical miles.

After the transmitter interrogates, the unit waits for a period of time corresponding to the ground station delay plus internal system delays and feeds the "crystal-derived" clock pulses into a series of digital counting and storage registers. A marker pulse is derived from the memory registers as they count the clock pulses. The marker pulse will then represent the total time required to convert a predetermined number in the storage registers into a time interval by the number of precise 0.1 nautical mile clock pulses. The marker pulse can then be compared in time with the received signal and continuously corrected to coincide with it. When this is done, the stored number that the marker was derived from represents the distance to the ground station.

To understand the mechanics of how the marker pulse is obtained, it is necessary to become familiar with the operation of the digital counting and memory circuits.

3.4.1 THE BINARY COUNTER.

A basic binary or bistable circuit is shown in figure 3-7. This circuit will rest in either one of two stable states. When triggered by an input pulse, the circuit switches to the second stable state where it remains until triggered by another pulse.

When a transistor is cut off, its output resistance is high and its collector current is effectively zero. However, current flow through the voltage divider network (resistors R_{11} , R_{f1} , and R_{b2} , because of collector supply voltage V_{CC} (+16 volts) causes finite voltage drops across each resistor. The voltage drop across resistor R_{11} is 1.4 volts, leaving nearly the full value of supply voltage V_{CC} at point C. The voltage drop across resistor R_{f1} is 14 volts, allowing for a base turn-on drop across Q_2 of +0.6 volts. Q_2 is then driven on by a base current of $I = \frac{14V}{R_{11}} = 1.4 \text{ ma}$. The high collector current (saturation) of the on transistor flow through resistor R_{12} and causes a voltage drop equal to the supply voltage V_{CC} , so that at point D, the voltage is essentially zero (0.2 volts or less). See figure 3-8.

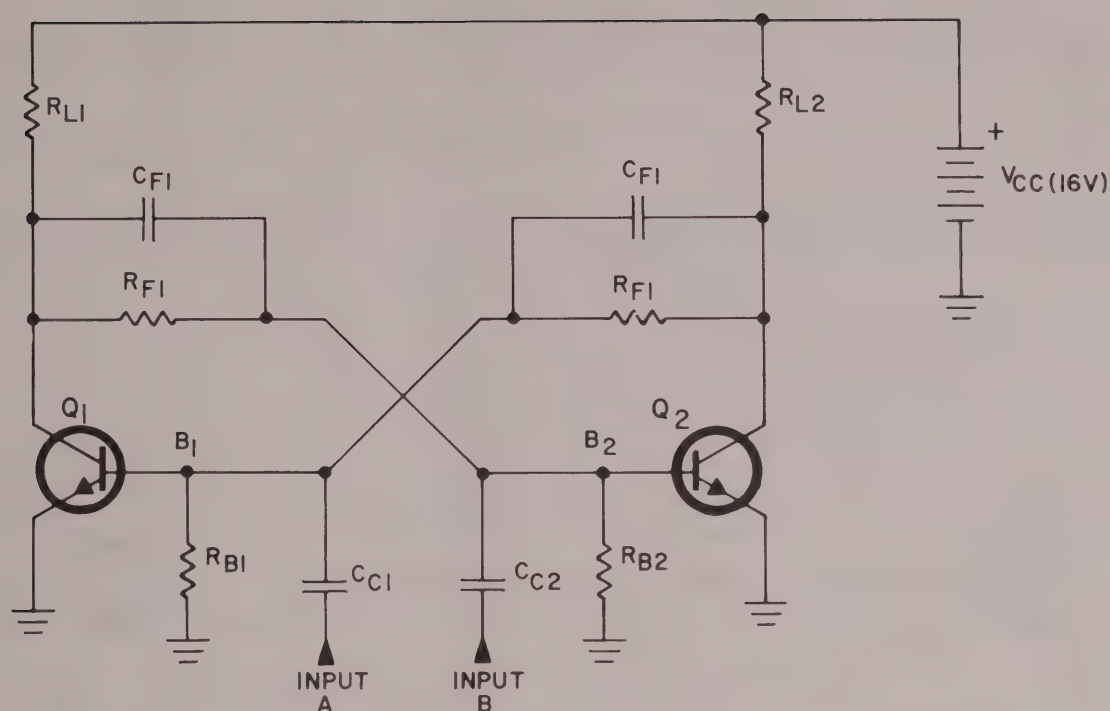


Figure 3-7. Basic Binary Circuit

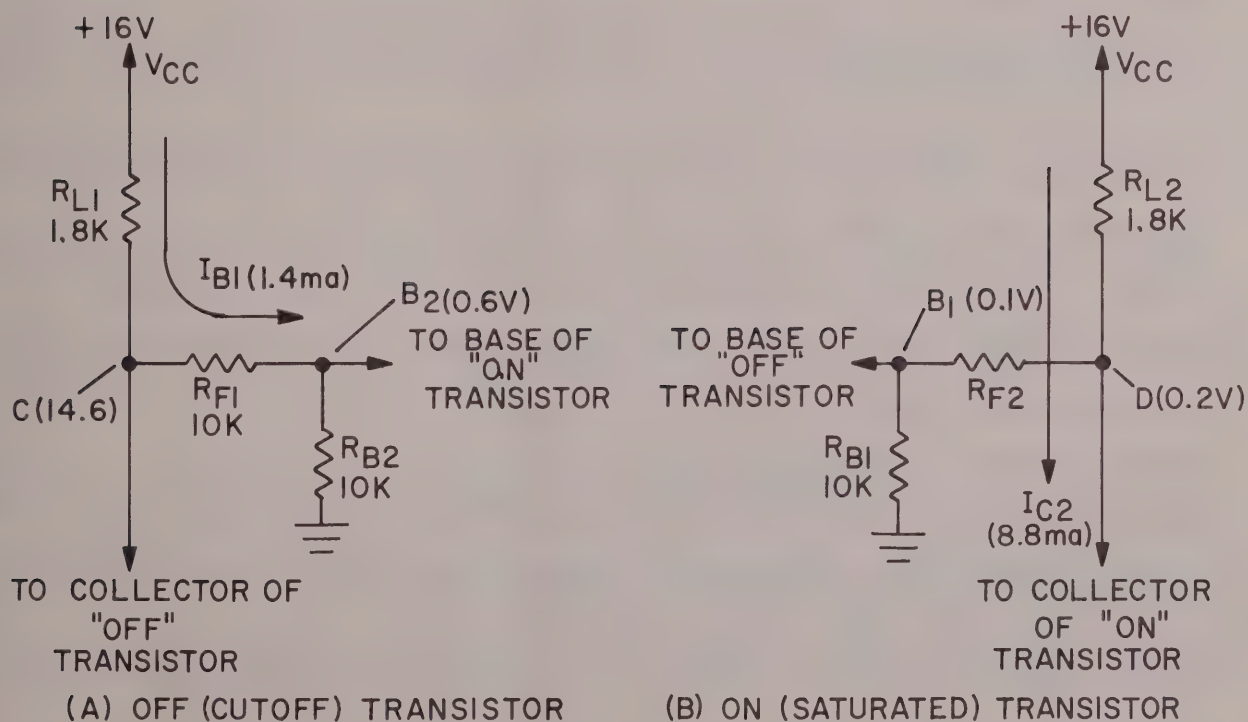


Figure 3-8.

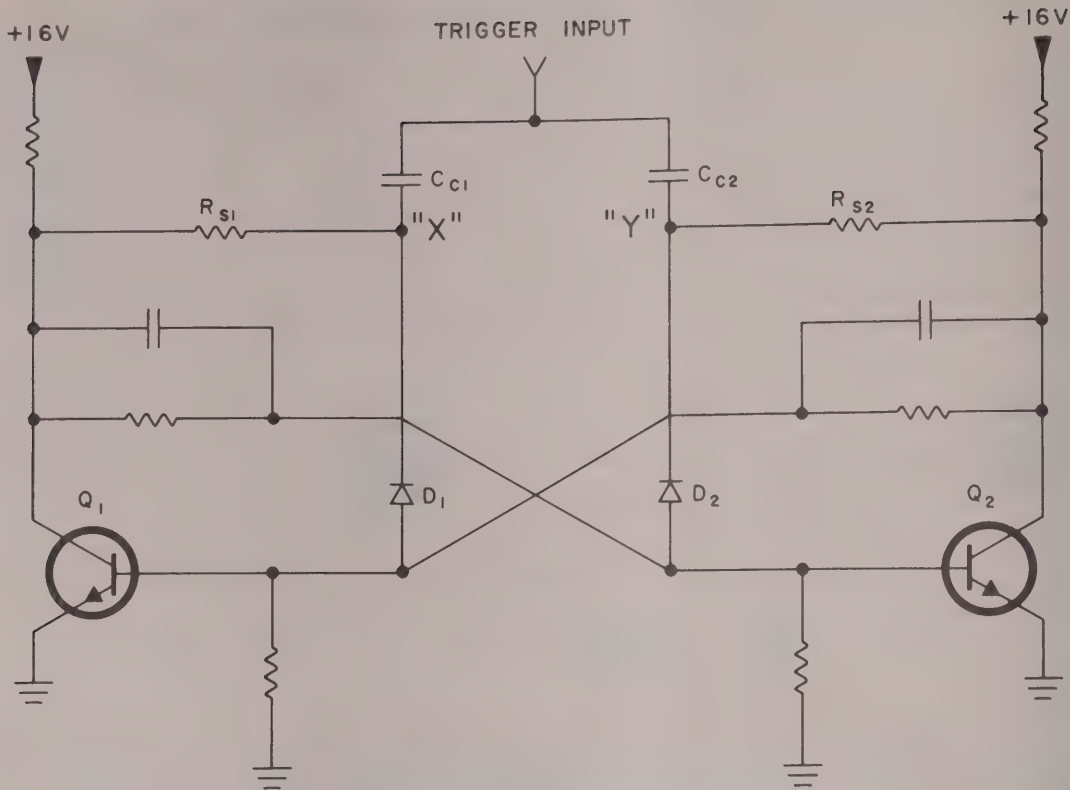


Figure 3-9. Binary with Steering Network Added

Division of this voltage by resistors R_{f2} and R_{b1} results in 0.1 volts or less at Q_1 's base. Although this is not a negative voltage, it may be thought of as reverse bias since a silicon transistor requires roughly 0.6 volts forward base to emitter voltage to conduct any appreciable collector current. Thus transistor Q_1 is held at cut off.

The application of a negative trigger pulse to the base of the on transistor or a positive pulse to the base of the off transistor will switch the conducting state of the circuit.¹

Two separate inputs are shown in Figure 3-7. A trigger pulse of the proper polarity at input A can change the state of the circuit. Once the state of the circuit is changed, an input of the same polarity at input B or an input of opposite polarity at input A will again change the state of the circuit.

Assume that transistor Q_1 is cut off and transistor Q_2 is conducting. A negative trigger pulse applied at input B reduces the base voltage of Q_2 to ground or below. Q_2 begins to turn off and the loss of collector current in Q_2 causes the collector voltage to increase towards V_{CC} .

This change in voltage is coupled through capacitor C_{f2} to the base of transistor Q_1 which increases its base to emitter voltage. As Q_1 's base voltage rises, Q_1 begins to draw collector current which reduces its collector voltage from near V_{CC} to a value nearer ground. This decreasing collector voltage is coupled through C_{f1} to further decrease the base current and voltage of Q_2 . This regenerative feedback continues until transistor Q_1 is in saturation and transistor Q_2 is cut off.

The output, taken between collector and ground, is a unit step voltage when a single trigger is applied. A square-wave output could be obtained through continuous pulsing or triggering of alternator inputs.

¹ In the higher speed logic circuits of the receiver/transmitter, negative going waveforms are generally used as triggered information. This is because negative going waveforms are derived from the collectors of transistors turning "on" and pulling a circuit point to $+V_{CC}$ to ground, and are thus sharper and of lower impedance than waveforms derived from transistors turning "off" (positive going).

Frequency division by a factor of 2 may be obtained if the two inputs are properly combined at one point and driven by a common trigger. To cause a change of state with a common input trigger, a steering circuit composed of resistors R_{S1} and R_{S2} and diodes D_1 and D_2 is added. See Figure 3-9.

This circuit now responds to negative going wave forms only, as diodes D_1 and D_2 will only conduct negative voltages to the bases of Q_1 and Q_2 .

Again assume Q_1 off and Q_2 conducting. Since Q_1 is off, its collector voltage will be high and C_{C1} will charge through R_{S1} so that the voltage at point X (Figure 3-9) equals nearly $+V_{CC}$. Similarly, the collector of Q_2 and point Y will be essentially at ground potential.

If the input signal (for example, from another binary) which was resting at $+V_{CC}$ suddenly changes level to ground potential, this change in level is momentarily coupled through capacitors C_{C1} and C_{C2} to points X and Y. The voltage at X, then goes from $+V_{CC}$ to nearly ground. As this level is not lower than the voltage at the base of Q_1 , diode D_1 does not conduct and no signal is coupled to Q_1 . At Y, however, the voltage was initially near ground and the coupled change in voltage pulls Y below ground to a negative voltage. This condition forward biases D_2 and removes drive from the base of Q_2 (the on transistor). Q_2 turns off and the circuit switches state as previously mentioned so that Q_1 is on and Q_2 is off.

Point X will go to ground potential and point Y will rise to nearly $+V_{CC}$ so that the next negative going input trigger will always be steered to the base of the "on" transistor.

The circuit switches states for each negative going input trigger, and at either collector a negative going output or "carry" is available for every second input trigger.

For oscillograms of typical binary operation, refer to the wave forms in the maintenance section.

3.4.2 THE QUINARY COUNTER.

The quinary counter is a circuit made up of five transistors and having five stable states rather than two, as in the binary counter.

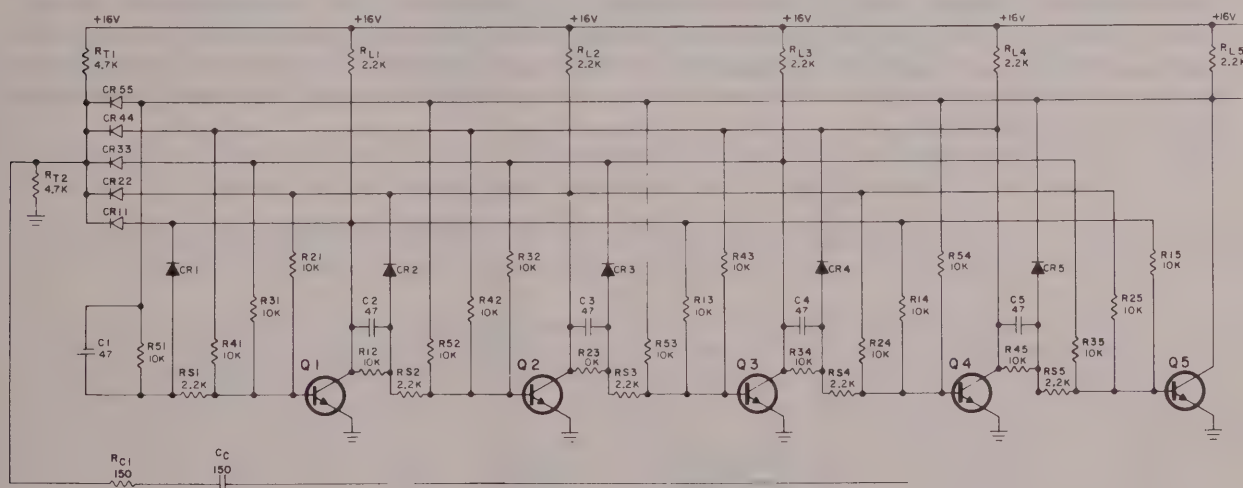
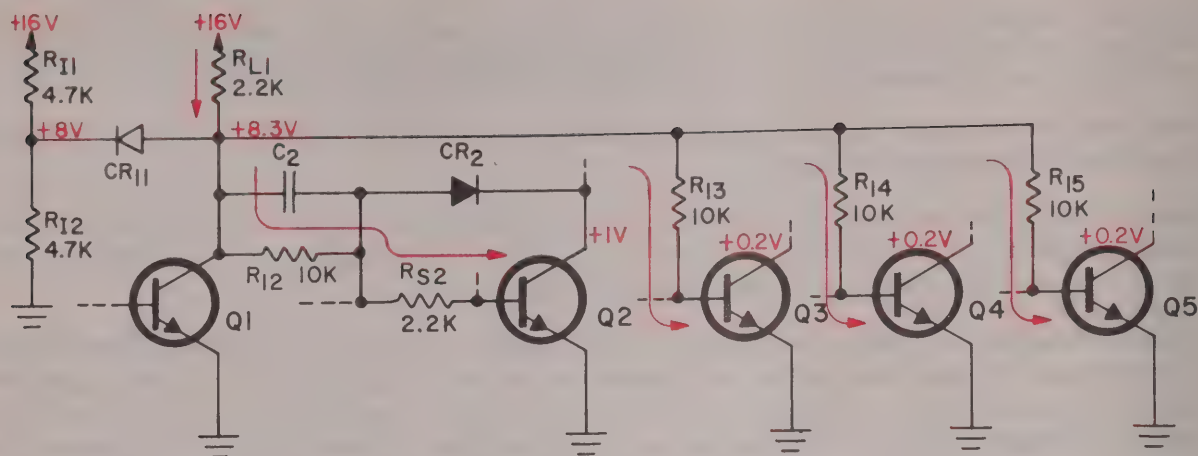


Figure 3-10. Quinary Counter

A stable state for this configuration is with one transistor off and the other four on. A total of five stable states then exist, depending on which transistor is off. Note that each base connects to the collector lines of the other four transistors through base drive resistors. Thus, the collector line of each transistor drives the bases of the other four transistors.

Assume Q_1 to be turned off. (See Figure 3-11.)

The high collector voltage of Q_1 drives the bases of Q_2 , Q_3 , Q_4 , and Q_5 respectively. (See Figure 3-10.) These collectors, being on, are all at low potential and the base of Q_1 is not driven. Therefore, Q_1 remains off and a stable condition exists.

Figure 3-11. Q₁ Collector Circuit

When a negative going input trigger is applied through C_c , the circuit will change stable states so that Q₂ is off and Q₁, Q₃, Q₄, and Q₅ are on.

This progression will continue from left to right until, on the application of the fifth trigger pulse, Q₅ will turn on again and Q₁ will be triggered off, restoring the quinary to its original state. In this circuit, collector triggering is used to shift the state, rather than base triggering. The negative going trigger wave form is coupled through C_c to the junction of R_{t1} and R_{t2} . Diodes CR₁₁, CR₂₂, CR₃₃, CR₄₄ and CR₅₅ in combination with R_{t1} and R_{t2} form a steering network which direct the trigger to the off transistor. (See Figure 3-12.)

In the example, since Q₁ is off, its collector voltage will be high and CR₁₁ will be slightly forward biased toward the 8 volt nominal voltage of the voltage divider formed by resistors R_{t1} and R_{t2} . The steering diodes are connected to on transistors and are thus reversed biased. As the input trigger reduces the steering junction towards ground potential, the collector line of Q₁ is forcefully pulled along by conduction through CR₁₁.

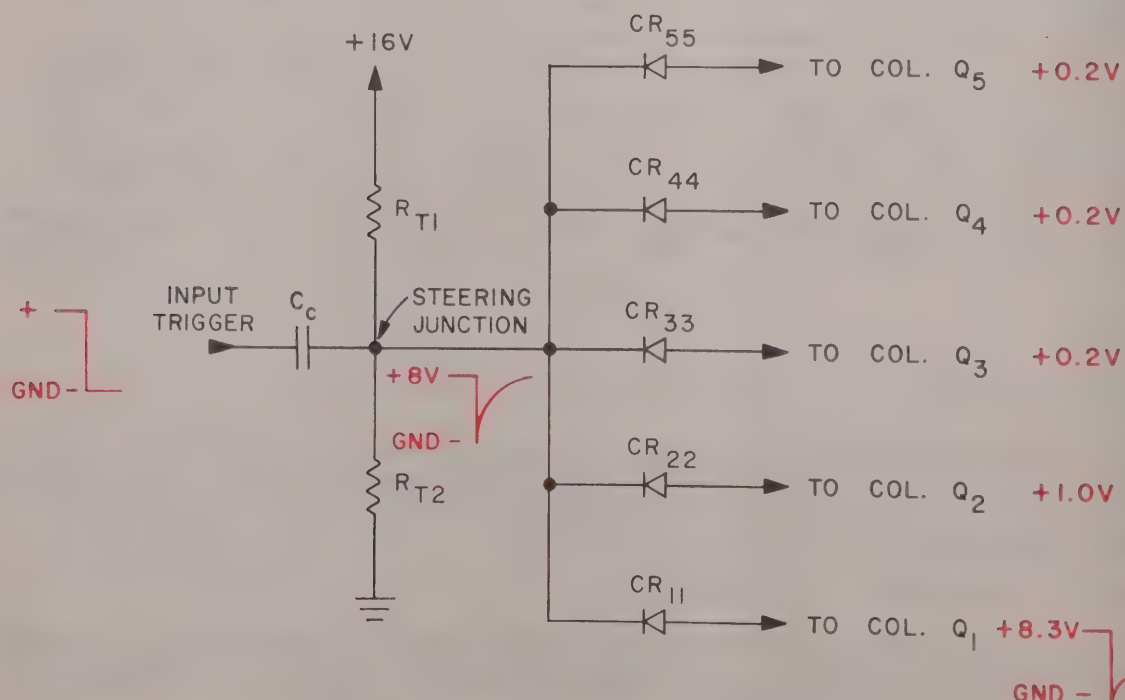


Figure 3-12. Quinary Triggering Circuit

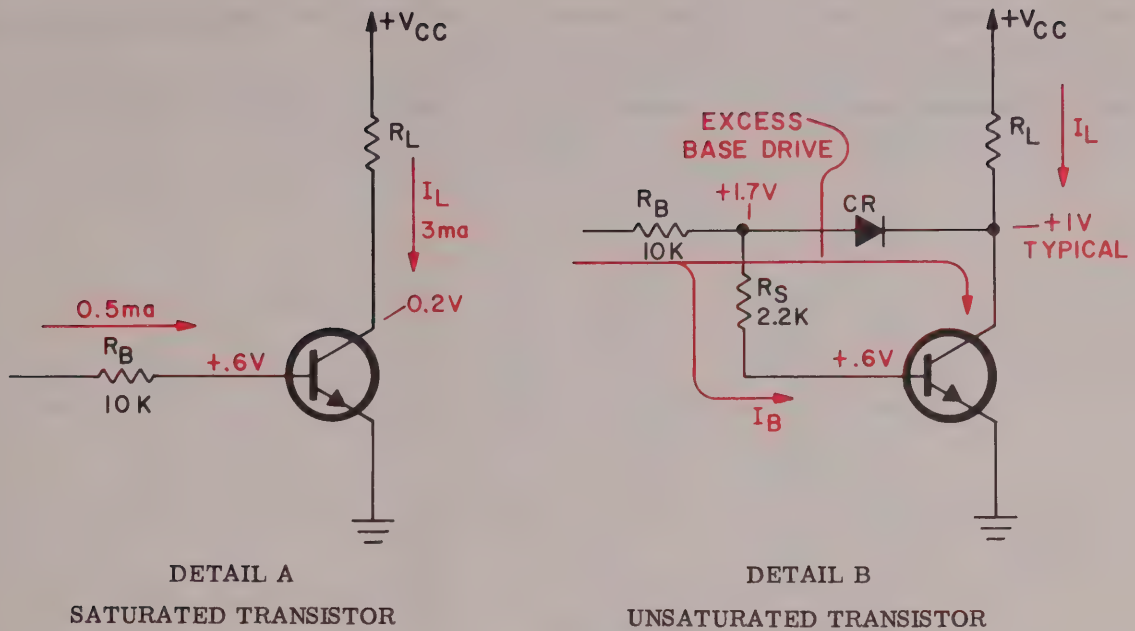


Figure 3-13.

Q_2 is the only transistor that is capacitively coupled to the Q_1 collector line; Q_3 , Q_4 and Q_5 are resistively coupled only. The decrease of voltage on the Q_1 collector line is coupled through C_2 to reduce the base drive of Q_2 through R_{S2} .

Q_2 begins to turn off and its collector voltage rises toward a +8 volt level due to current through R_{12} . When this voltage rises to about +3 volts, Q_1 begins to receive appreciable base drive from the Q_2 collector line through R_{21} . Q_1 begins to turn on and reduce its collector line voltage (up to this time the decrease in collector voltage of Q_1 was due to the trigger pulse). The process, once started, continues regeneratively until Q_2 is off and Q_1 is on. Q_2 is then without base drive and remains off as its base network is connected to four on transistors.

During the switching process, Q_3 , Q_4 and Q_5 are unaffected and remain on because the loss of base drive from the Q_1 collector line is made up by an increase in drive from the rising Q_2 collector line.

To additionally insure that Q_2 will turn off first and assume the job of holding Q_1 , Q_3 , Q_4 and Q_5 on, the Q_2 , when driven from the Q_1 collector line, will be conducting but not unsaturated.

A saturated transistor is one in which the base drive current is more than sufficient to cause the collector current to be entirely limited by external circuit resistance; i. e., suppose the transistor in Figure 3-13 has a current gain "Beta" of 30. The collector current through R_1 with the resistor fully on is 3 ma. No matter how large the base drive, the transistor can pull no more than 3 ma through R_1 . Any base drive then, above the requirements $3 \text{ ma}/30 = 0.1 \text{ ma}$, is a margin and if, say 0.5 ma is available, the transistor is said to be saturated. (See Figure 3-13, Detail A.)

A base circuit is shown modified in Figure 3-13, Detail B, by the addition of a resistor R_S and diode CR. The diode is connected between the tap on the base drive resistance and the collector. When the collector voltage falls below the voltage at the tap, the diode conducts and diverts base current into the collector. Once the collector voltage reaches this low value, the base current is reduced to whatever value is necessary to maintain the collector current, and the transistor is said to be on but unsaturated and there is no excess base drive.

A saturated transistor shows a longer turn off time than an unsaturated one. The condition of excess base drive and minimum collector voltage causes a storage effect. This is seen as a time delay between the time when base drive is removed and the time the collector current begins to decrease.

Referring back to the quinary circuit with Q_1 off, (Figure 3-11) it can be seen that Q_2 is on but unsaturated as excess base drive is shunted from R_{S2} by CR₂. Q_3 , Q_4 and Q_5 are saturated as their base drive from Q_1 does not pass through a nonsaturating path.

Thus Q_2 , in addition to being capacitively coupled to Q_1 , is unsaturated when driven by an off Q_1 and is "made ready" to turn off in preference to Q_3 , Q_4 and Q_5 .

The same situation applies to Q_3 when driven by Q_2 , etc., through Q_1 driven by Q_5 .

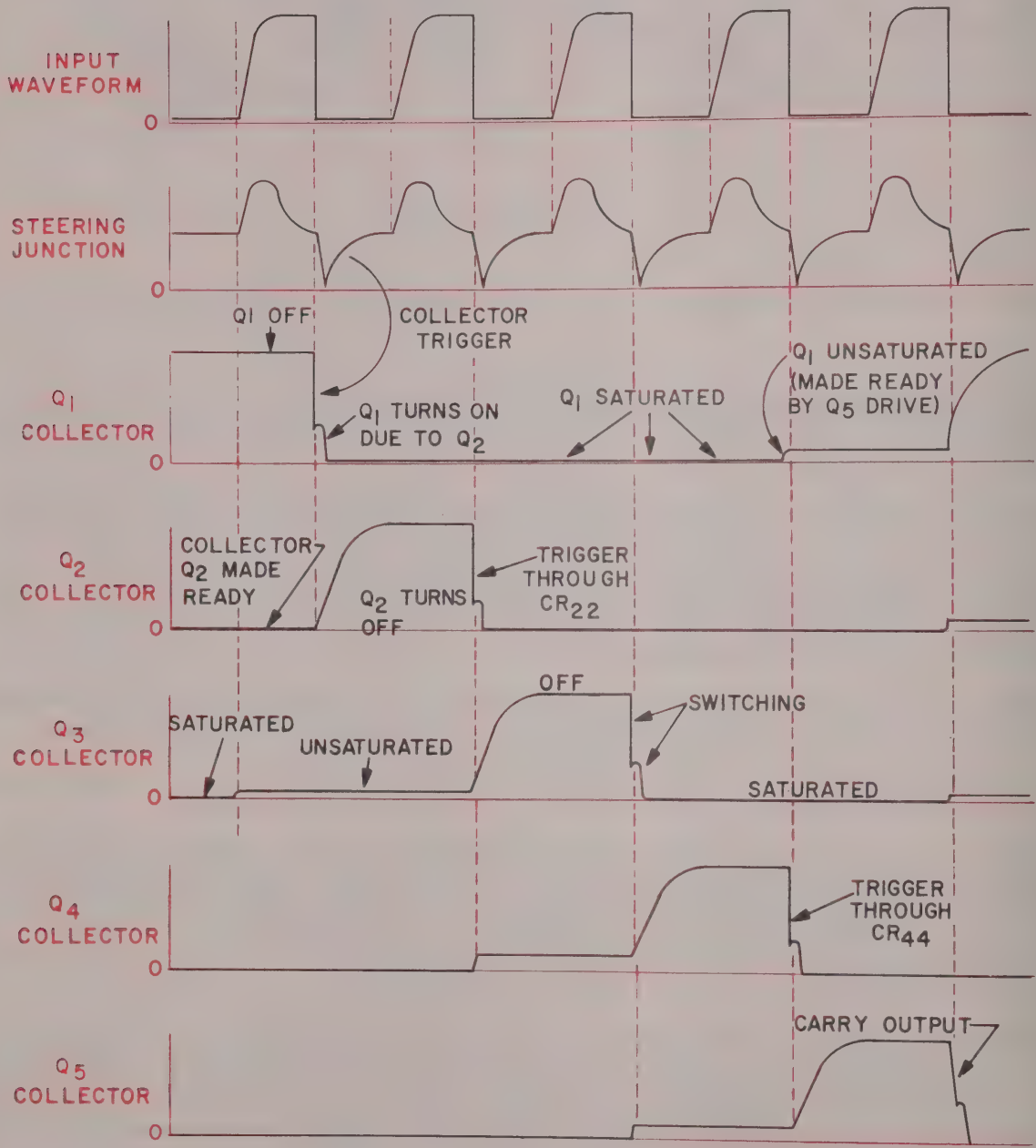


Figure 3-14. Quinary Wave Forms

3.4.3 THE BIQUINARY COUNTER.

The combination of a binary and a quinary circuit gives a biquinary or scale of ten counter. Shown in Figure 3-15, is range board count biquinary. The binary furnishes to the quinary a negative-going output at Q-921 for every second input trigger. The quinary provides a negative going output or "carry" at the collector of Q-933 for every fifth binary output. Figure 3-15 shows a chart which describes the states of each transistor at the end of each negative-going input.

Pulse	Q921	Q922	Q929	Q930	Q931	Q932	Q933
0	on	off	off	on(ns)	on	on	on
1	off	on	off	on(ns)	on	on	on
2	on	off	on	off	on(ns)	on	on
3	off	on	on	off	on(ns)	on	on
4	on	off	on	on	off	on(ns)	on
5	off	on	on	on	off	on(ns)	on
6	on	off	on	on	on	off	on(ns)
7	off	on	on	on	on	off	on(ns)
8	on	off	on(ns)	on	on	on	off
9	off	on	on(ns)	on	on	on	off
10	on	off	off	on(ns)	on	on	on*

(ns): non-saturated

*carry pulse at this time.

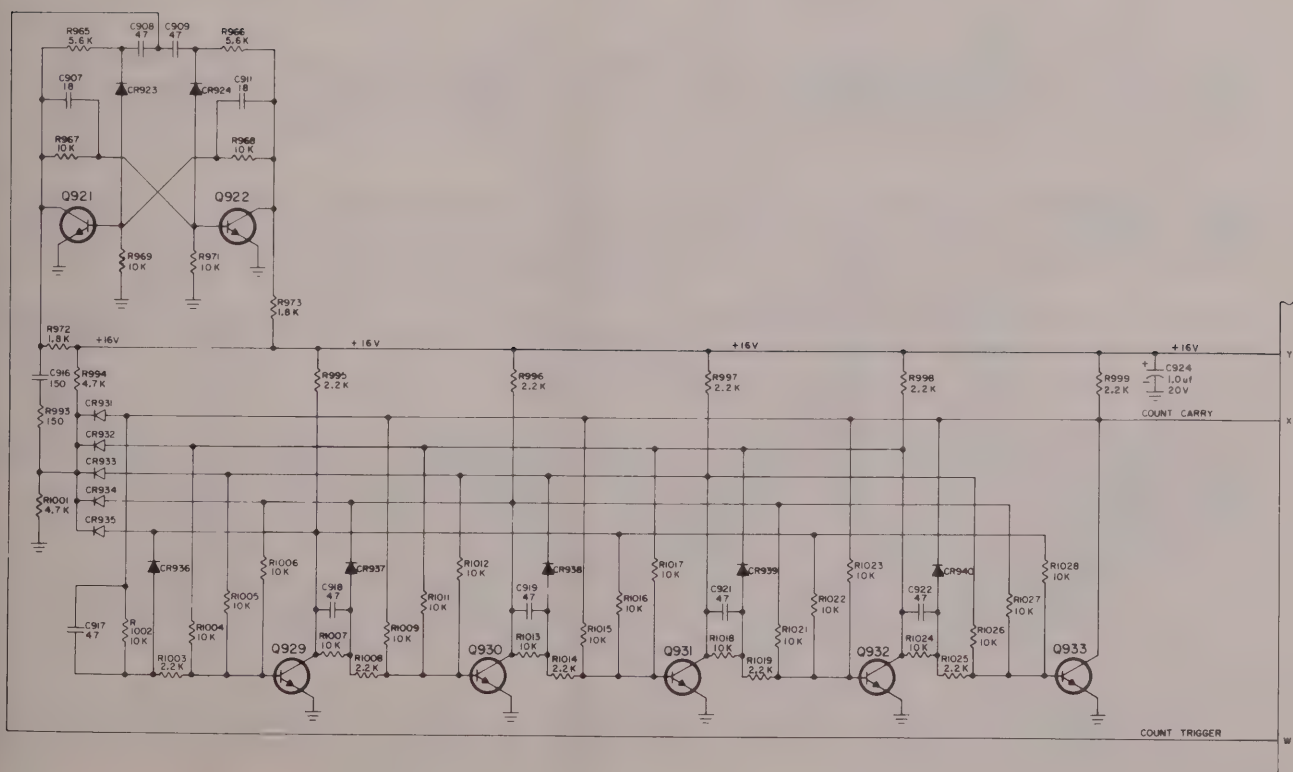


Figure 3-15. Biquinary Counter

3.4.4 THE SCHMITT TRIGGER.

The Schmitt circuit (Figure 3-16) differs from the conventional binary circuit in that one of the coupling networks is replaced by a common emitter resistor. This provides regenerative feedback while leaving one collector and one base free and independent for output and input considerations.

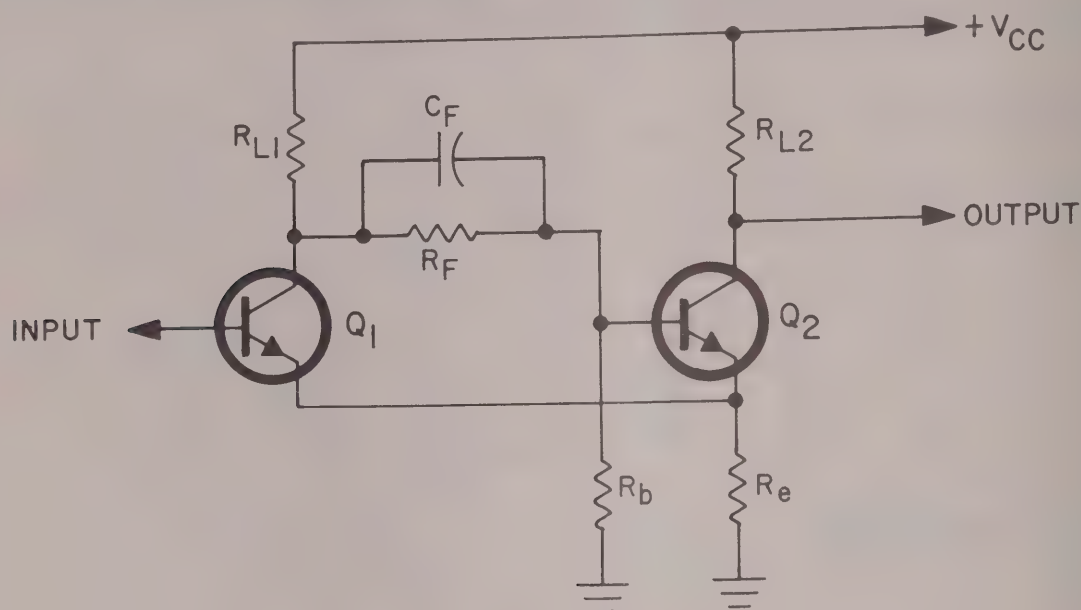


Figure 3-16. Schmitt Trigger

Assuming a quiescent condition (no input) with transistor Q_1 at cutoff, the collector voltage of Q_1 is nearly equal to the supply voltage V_{CC} . This positive voltage is coupled to the base of transistor Q_2 through resistor R_F .

Current flow from the emitter of transistor Q_2 through the common emitter resistor R_E , holds the emitter of Q_1 at a positive potential with respect to its base, maintaining it in a cutoff condition. The high positive voltage at the base of Q_2 produces forward bias for its base emitter junction causing it to operate in the saturation region.

A positive signal of sufficient amplitude applied to the base of Q_1 , will allow Q_1 to conduct, causing the collector voltage to decrease. This change is coupled through C_F and R_F to the base of Q_2 . The emitter current of Q_2 decreases, lowering the potential across resistor R_E .

The emitter of transistor Q_1 becomes less positive, reducing the reverse bias and increasing collector current. This regenerative action continues until transistor Q_1 is operating in the saturation region and transistor Q_2 is cut-off. The output is a high positive voltage.

This new condition continues until the input begins to fall (becoming more negative). This negative going input decreases the base potential of transistor Q_1 reducing its forward bias. This causes the collector voltage to increase, emitter current to decrease, and the potential across resistor R_E to decrease. Simultaneously, the increasing (positive) voltage at the collector of transistor Q_1 is coupled to the base of transistor Q_2 driving it positive. The decreasing voltage of resistor R_E , due to Q_1 being cut-off, causes the emitter of Q_2 to become less positive. Both actions tend to increase the forward bias of the emitter to base junction and Q_2 again operates at saturation, cutting off transistor Q_1 and returning the circuit to its original operating conditions. The output is a low positive voltage.

The rise and fall time of the output wave of this circuit is shorter than that of the conventional binary circuit. The shape of the output wave form does not depend on the shape of the input wave form. The output wave form changes between its two values of output voltage only when the input wave form passes through the switching points of the circuit.

3.4.5 THE COUNT LOOP.

The count loop is a major subsystem in the video section of the receiver/transmitter. Its basic function is to count and gate 2,000 precision clock pulses each time the DME interrogates the ground station. The reason for counting 2,000 pulses will be explained shortly. The count loop is also instrumental in an addition-subtraction operation. Parts of the count loop are located throughout four of the six video plug-in cards. The count loop circuit is shown in Figure 3-18 and the loop block diagram is shown in Figure 3-17.

Q-804 and Q-805 form a set-reset (clock gate) binary which can be set from a negative-going clock gate input (Pin V, J-407). Once set it can be reset only by a negative going change of state of Q-809. Q-809 and Q-810 form a trigger binary in the hundred mile (1,000 - 2,000 count) circuit. Q-806 and Q-807 comprise a Schmitt trigger as previously discussed, with the addition of L-801 in the collector of Q-807. This inductor speeds up the switching of the large capacitive loads on the Schmitt. Two resistors combine at the base of Q-806; R-821 from the collector of Q-805 and R-822 from the clock input (Pin V, J-407). The clock input is an 800 kc wave form which alternates between +16 volts and ground (see Figure 3-18). R-821 and R-822 form an "and" gate with the Schmitt so that when either (or both) Q-805's collector and the clock gate input is positive, Q-806 is held on and the collector of Q-807 remains at a high positive value. For Q-806 to turn off, both Q-805 and the clock gate input must be at ground potential. When both inputs go to ground, a negative going output pulse is obtained as Q-806 turns Q-807 on. This pulse travels through C-813 and CR-810 to the trigger input of the 0.1 mile count biquinary on range board #3. CR-809 provides a dc charge path for C-813. The other components at this point, CR-811, CR-812, etc., allow other pulses to be gated to the count chain without loading or being loaded by the Schmitt trigger.

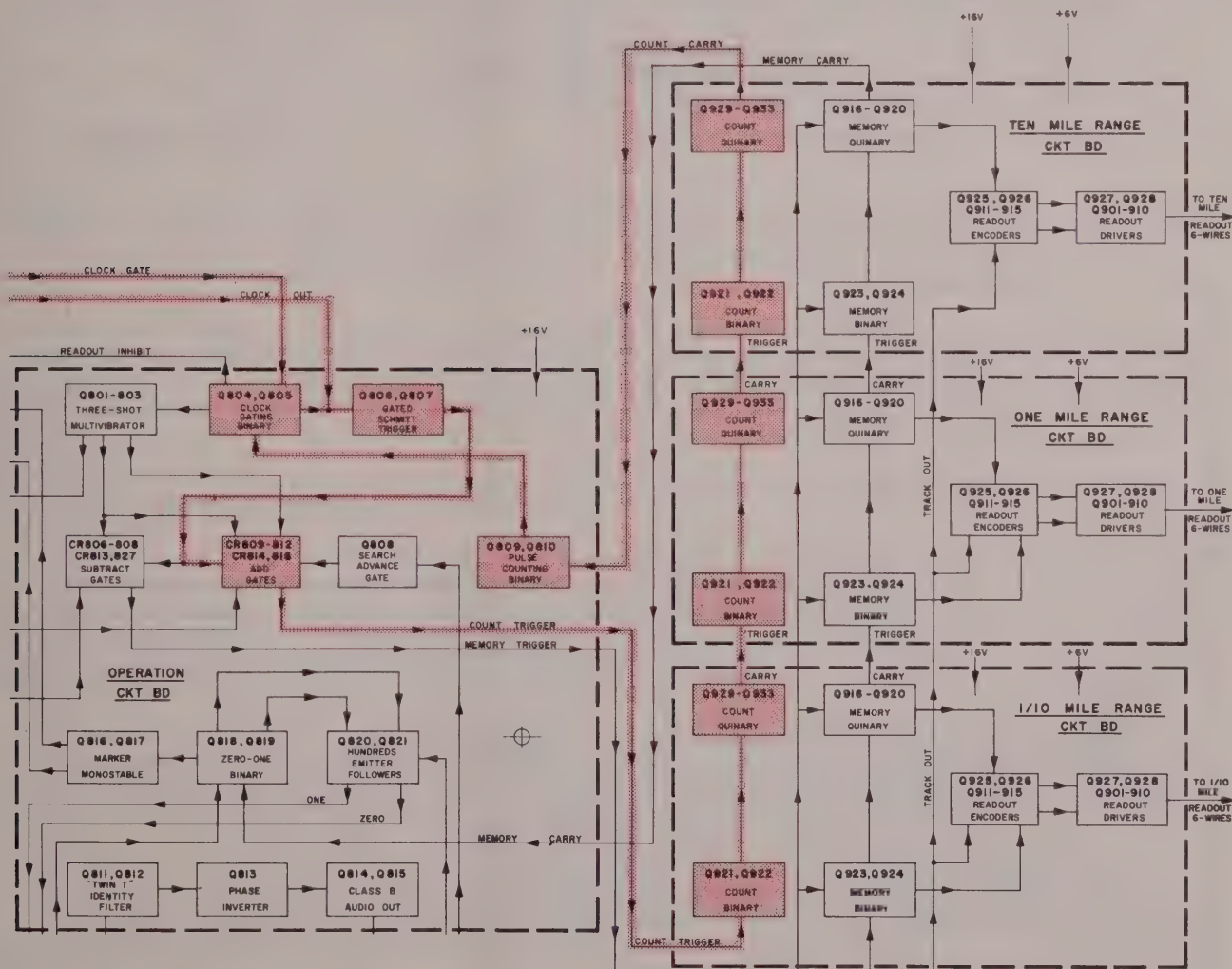


Figure 3-17. Count Loop Block Diagram

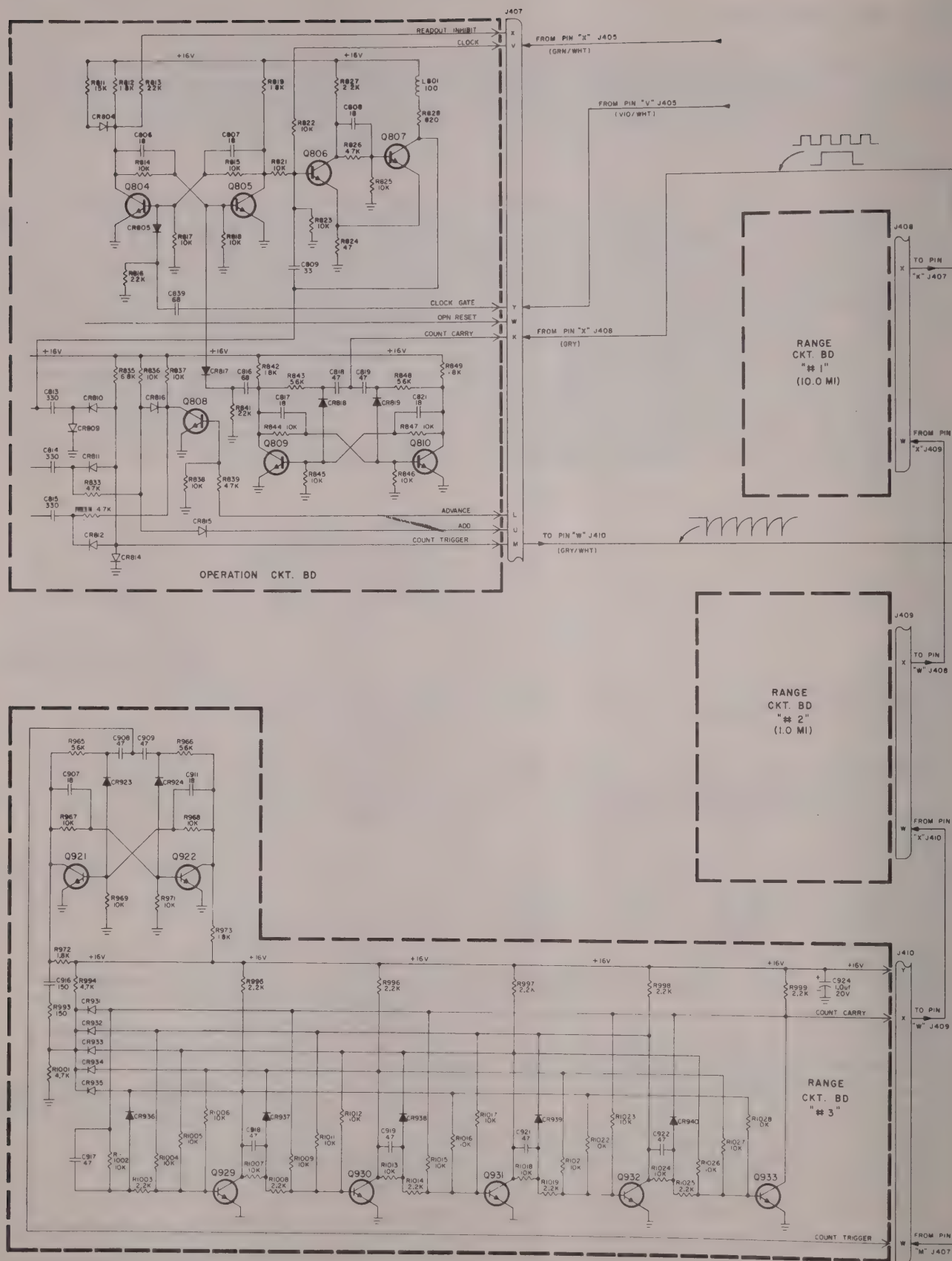


Figure 3-18. Count Loop Circuit

The sequence of operation is as follows: When the clock gating binary receives a negative going pulse from the initiation board to start the count, the binary allows the gated Schmitt to trigger on the next low voltage point of the square wave clock input. The Schmitt will then follow the clock wave form with a square wave output for as many cycles as permitted by the gating binary.

The negative going edges of the Schmitt output produce sharp, negative spikes, one for each clock cycle. These spikes are counted by the range board (0.1 mile) so that for each ten input pulses a negative going output carry is obtained. This output is coupled to the second range board which then gives a carry output for each ten of its input pulses or for every hundred Schmitt pulses. The last (10 mile) range board in the chain similarly carries once for every thousand of the original pulses.

The first carry out of the last range board will trigger the pulse counting binary (W-809, Q-810) on the operation board so that Q-809 turns off and Q-810 turns on. Remember that this pulse represents 1000 gated clock cycles. The second carry pulse (representing the second set of 1000 pulses) will turn Q-810 back off and turn Q-809 on. As the collector of Q-809 travels from a positive voltage to ground potential, a negative spike appears at C-816 and is coupled through CR-817 to the base of Q-805. Q-805 turns off, the gating binary is reset and locks the Schmitt off again. In this manner, the count loop has counted 2,000 clock pulses and stopped the count at that number. Note also that the pulse that reset the gating binary was caused by a carry pulse from the counting binary.

Fractions of a microsecond prior to that time, the counting binary was triggered by a carry pulse from the count biquinary in the ten mile range board. That range board carry was caused by a carry from the one mile range board, which in turn was caused by a carry from the tenth mile range board. That particular carry of course, was produced by the 200th pulse. Thus, the last pulse causes a carry condition to ripple through from the first count biquinary to the gating binary and shut off the Schmitt Trigger before another clock pulse is gated through.

This leaves each counter circuit in the count chain in the condition of just having carried to the next register. The loop is then again ready to count a full 2,000 pulses for the next cycle.

3.4.6 THE MEMORY CHAIN.

The memory chain has three basic functions: (1) To store a number representing distance. (2) To drive the readouts in such a fashion that this number is presented to the operator. (3) To convert the stored number into a time interval by means of accurately spaced clock pulses. The first two functions can be understood by reference to Figure 3-19.

There are ten possible conditions, or states, formed from the two states of the binary counter and the five states of the quinary counter. Since the binary preceeds the quinary in the circuit, it changes state every input pulse. The binary state is an indication of whether the number is odd or even, as the original state will be repeated every second input pulse. The binary drives the emitter followers Q-925 and Q-926, which in turn, feed the readout "common" drivers Q-927 and Q-928.

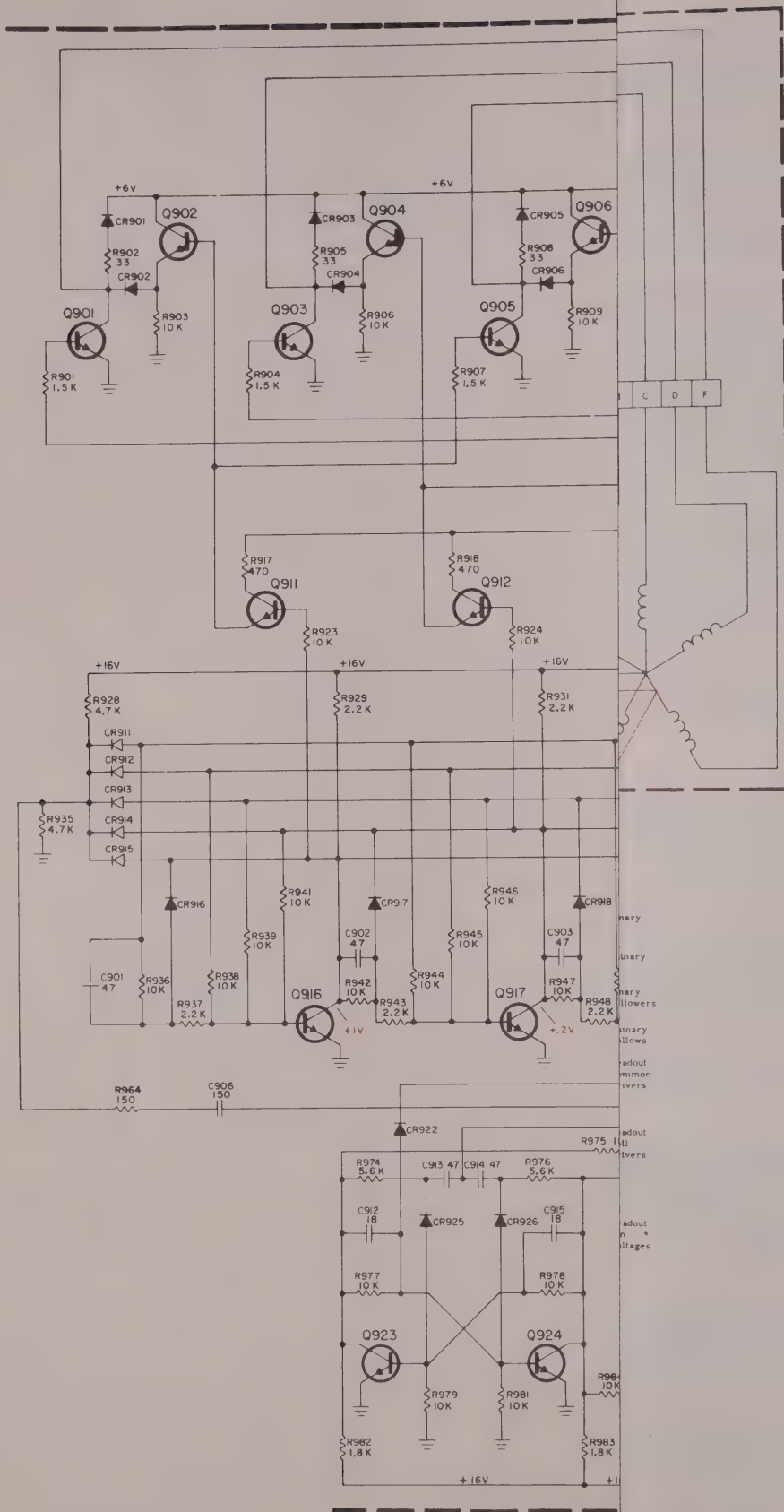
These two transistors determine the polarity of the readout common, which will either be held at +6 volt dc through Q-927 or at nearly ground potential by Q-928.

Selection of one of the five readout coils is made by the quinary counter. In Figure 3-19, assume Q-920 is the off transistor. The off Q-920 turns Q-915 on. With Q-915 on, both the Q-903 and the Q-910 coil drives are turned on. This places a ground on readout coil "D" and +6 volt dc on coil "A". Referring to the chart on Figure 3-19, this selects either the number "1" or the number "0". The polarity of the readout common then determines which coil that current will flow through and therefore, which of these two numbers will be presented.

On Pins "U" and "H" of each Range Board plug is an input called "track". This voltage is positive when the counters are idle. During the time that the counters are active the track input goes to ground potential. This "kills" the binary and quinary followers to prevent the readouts from being driven and prevents the readouts from jittering or moving erratically by removing drive while the counters are switching.

The first two functions of the memory chain have been discussed: That of storing a number and reading that number out. Although the process of presenting a particular number from a stored condition is somewhat complicated, it is relatively straight forward and the mechanics can always be followed for each digit by reference to Figure 3-19.

The third function of the memory chain is to convert the stored number into a time delay by counting the number of clock pulses. This principle is used to realize one of the basic advantages of a digital approach to Distance Measuring Equipment; the accuracy of this time delay is essentially that of the source of clock pulses. With the receiver/transmitter clock pulses generated by a crystal oscillator,



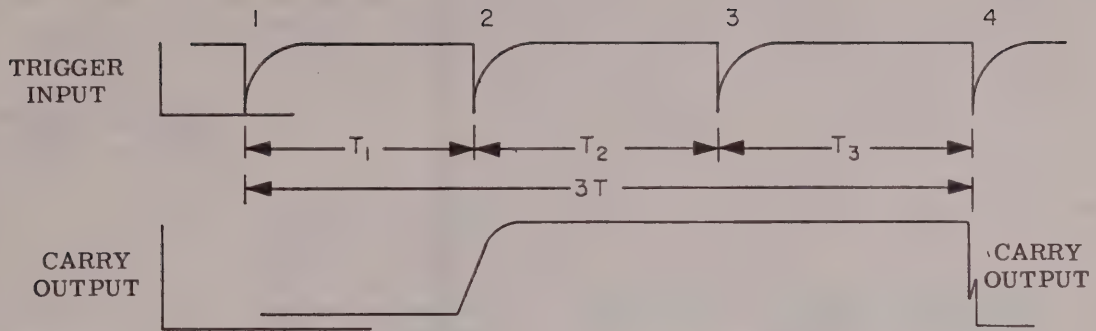


Figure 3-20. Trigger Wave Forms

this stable frequency source becomes the primary distance standard.

The counter-readout encoding circuitry is arranged so that the number presented to the operator is a function of the number of additional pulses that must be fed to the counter before it clears. Suppose that a memory counter is storing and displaying a "0". This means that the next trigger pulse into the counter will cause the counter to clear, or carry. Again, a carry output is one where the output wave form goes rapidly from some positive voltage to ground potential. In the case of a "0" readout then, the time delay between the trigger input and the carry output will be very short in comparison to the time between clock pulses and will depend only on the switching time of the transistors in the counter (on the order of 10 to 50 nanoseconds.) The time delay in this case could be said to be zero input intervals.

If, for example, the number "3" is stored and displayed, the circuit is so arranged that it will take three input triggers before the counter will be ready to carry. At the instant of the fourth trigger input, the counter will carry. This time delay between the first trigger input and the carry input will be the total time between the first and the fourth triggers or three trigger intervals. See Figure 3-20.

In Figure 3-20 the trigger input wave form may vary slightly from that shown, since the trigger may come either from the Schmitt trigger's gated output or from another memory counter, depending on a particular counter's position in the memory chain. What is important to one's reasoning at this point is the negative-going points on the trigger wave form and the time interval between these points.

Returning to Figure 3-19, the condition of a stored "3" would be Q-923 and Q-919 off in the biquinary counter. This condition presented to the encoding and driving circuitry would result in a number "3" presentation by the readout.

The first trigger into the counter will reverse the state of the binary counter by turning Q-924 off and Q-923 on. The second trigger will again reverse the binary. As Q-924 turns on, the negative going collector voltage will trigger the quinary counter so that Q-920 turns off and Q-919 turns on. The third trigger input will again reverse the binary so that Q-924 is off and ready for another carry. The leading edge of the fourth trigger will cause the binary to reverse and carry to the quinary. This immediately causes the quinary to carry as Q-920 turns on. Three time intervals will then have elapsed between the time the first trigger was applied and the time the counter carried.

The memory registers are connected in a series hookup similar to the count registers in the count loop. (See figures 3-21 and 3-22.)

There are three decade counters in the memory chain followed by a binary counter. This gives a total memory capacity of 2,000 states or up to 199.9 nm range readout capacity (000.0 is a state).

The last memory binary is located on the operation board (Q-818, Q-819) and follows the ten mile memory counter in sequence. (See Figures 3-21 and 3-22). This binary drives the hundred mile digit on the indicator to either a one or a blank by means of emitter followers, Q-820 and Q-821, which in turn drive the hundreds readout drivers Q-505 and Q-506 located on the initiation board. (See receiver/transmitter block diagram, Figure 7-1.)

For example, suppose the number stored is 121.5. This means that the 0.1 mile memory register can receive five input pulses before it is ready to carry to the 1.0 mile memory register. On the sixth

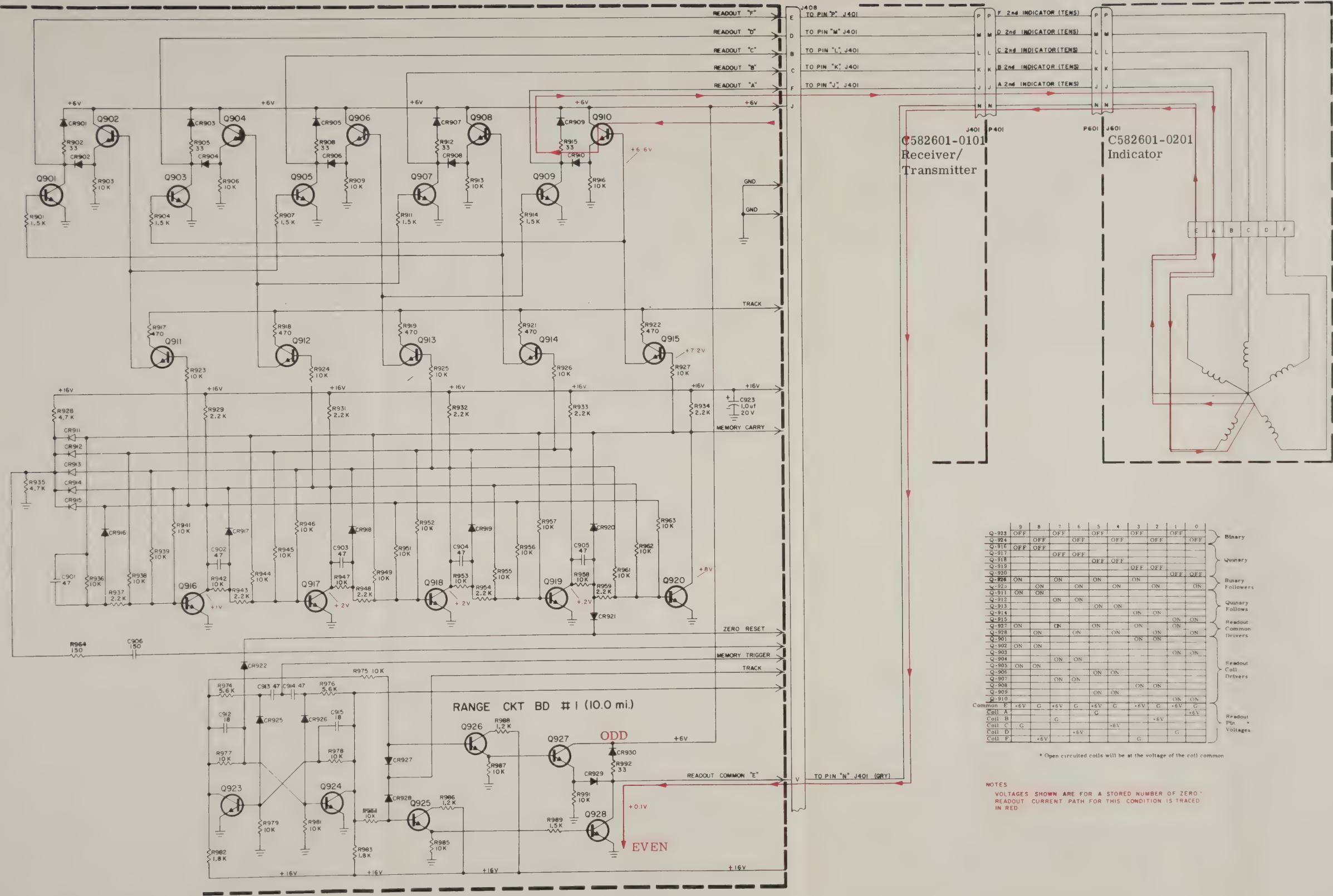


Figure 3-19. Range Board Memory Section and Readout Wiring Diagram

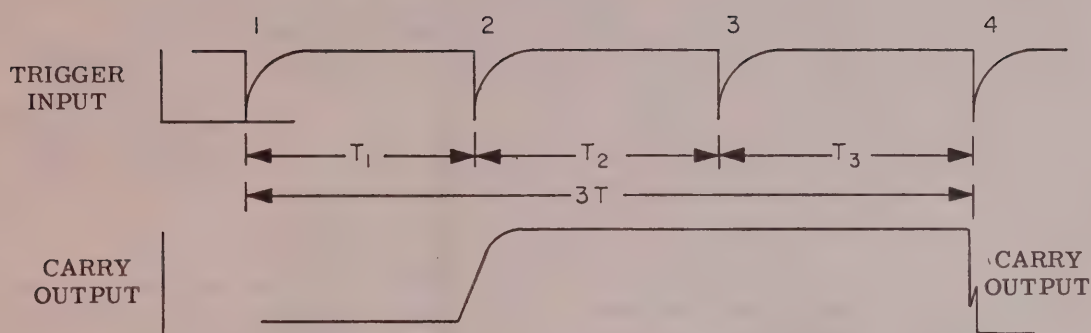


Figure 3-20. Trigger Wave Forms

this stable frequency source becomes the primary distance standard.

The counter-readout encoding circuitry is arranged so that the number presented to the operator is a function of the number of additional pulses that must be fed to the counter before it clears. Suppose that a memory counter is storing and displaying a "0". This means that the next trigger pulse into the counter will cause the counter to clear, or carry. Again, a carry output is one where the output wave form goes rapidly from some positive voltage to ground potential. In the case of a "0" readout then, the time delay between the trigger input and the carry output will be very short in comparison to the time between clock pulses and will depend only on the switching time of the transistors in the counter (on the order of 10 to 50 nanoseconds.) The time delay in this case could be said to be zero input intervals.

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The memory registers are connected in a series hookup similar to the count registers in the count loop. (See figures 3-21 and 3-22.)

There are three decade counters in the memory chain followed by a binary counter. This gives a total memory capacity of 2,000 states or up to 199.9 nm range readout capacity (000.0 is a state).

The last memory binary is located on the operation board (Q-818, Q-819) and follows the ten mile memory counter in sequence. (See Figures 3-21 and 3-22). This binary drives the hundred mile digit on the indicator to either a one or a blank by means of emitter followers, Q-820 and Q-821, which in turn drive the hundreds readout drivers Q-505 and Q-506 located on the initiation board. (See receiver/transmitter block diagram, Figure 7-1.)

For example, suppose the number stored is 121.5. This means that the 0.1 mile memory register can receive five input pulses before it is ready to carry to the 1.0 mile memory register. On the sixth

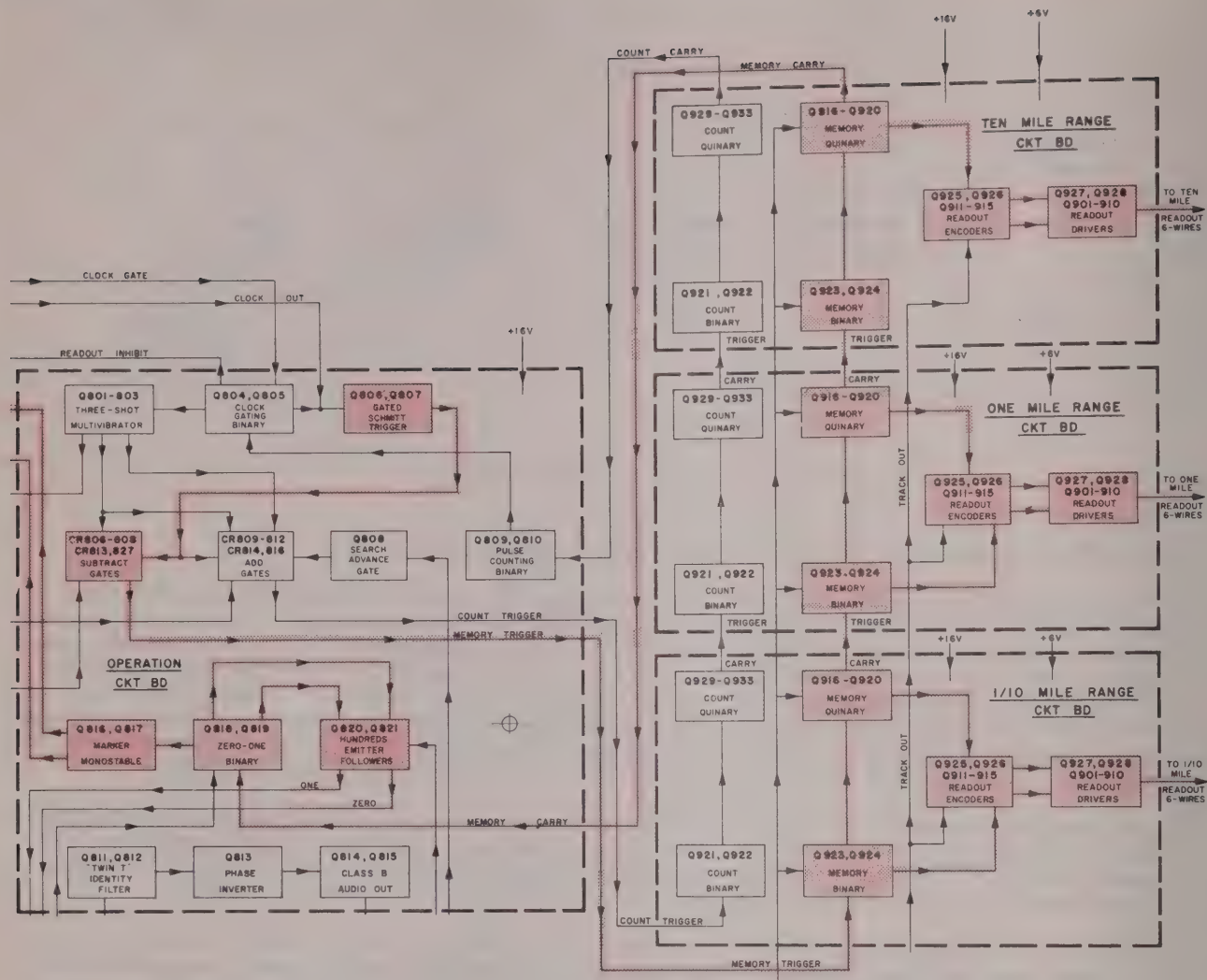


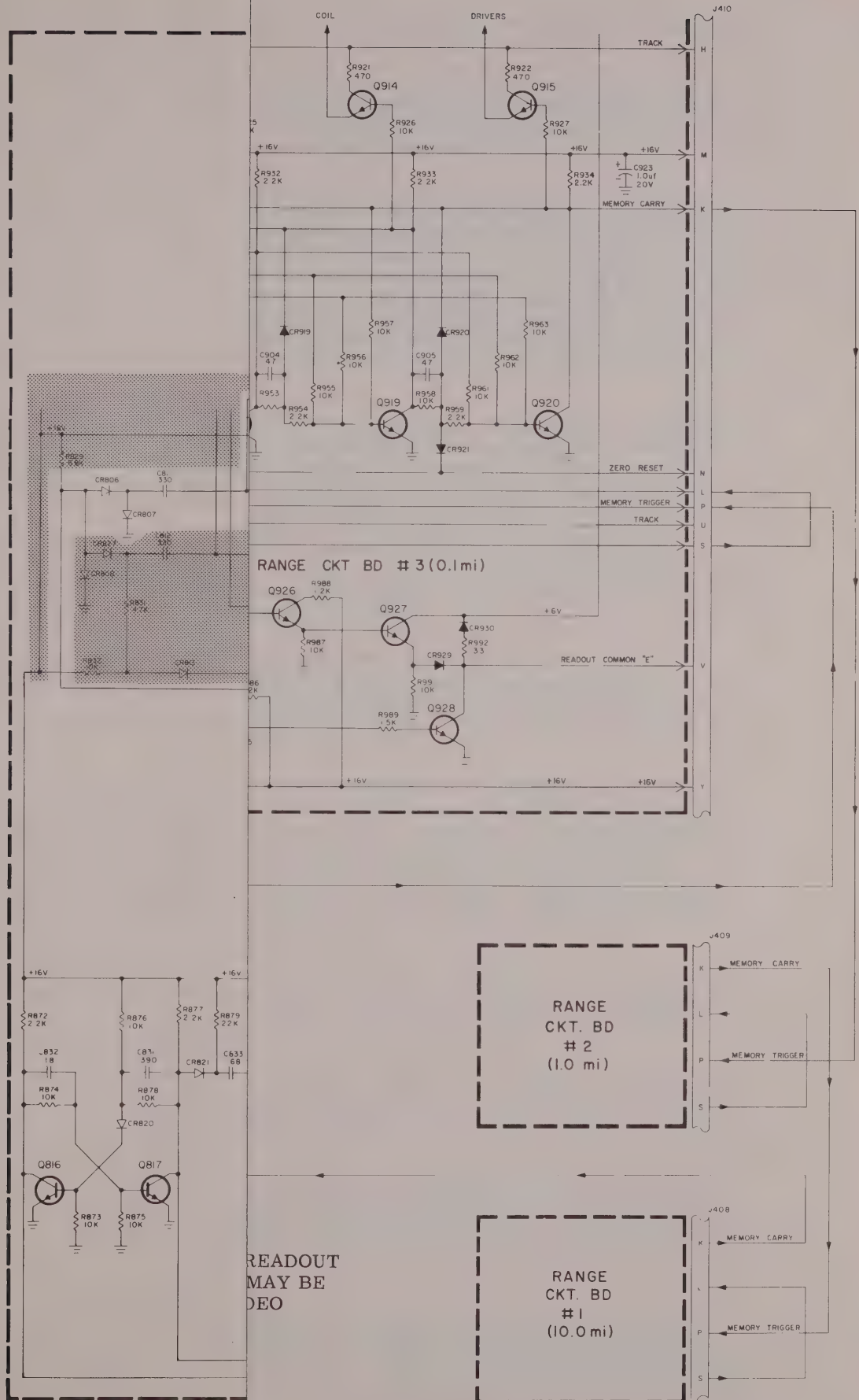
Figure 3-21. Memory Chain Block Diagram

input pulse (five complete clock time intervals) it will carry to the next counter. At that instant of time the stored number will have been reduced to 120.9. The addition of nine more clock pulses is required to shift the 0.1 mile register down to zero again. The number stored is now 120.0. The next pulse into the 0.1 mile register will cause it to carry to the 1.0 mile register. However, the 1.0 mile register is storing a zero and must carry on an input. Therefore, it will immediately carry to the 10 mile register, reducing its pulse-to-carry number by one. The stored number is now 119.9. 6-9-1 or 16 pulses have entered the 0.1 mile register to this time and 15 time intervals have elapsed.

The process will continue at a rapid rate (800 kc) until the stored condition of the registers have been reduced to 000.0. At this instant 1215 clock pulses have entered the 0.1 mile register. The hundred mile zero-one binary is now ready to carry for the first time. On the 1216th pulse, each register will carry to the next and this condition will ripple through all four counters. The carry from the zero-one binary triggers the marker monostable (Q-816 and Q-817). A total time of 1215 clock intervals has elapsed from time of the first clock pulse input to the time the marker appears.

The clock frequency is such that the spacing between clock cycles, or period, corresponds to the time it takes a radio or light wave to travel a round trip one tenth nautical mile. This makes the time interval between the first input pulse and the marker, in the above example, the same time delay that might be expected between transmission and reception of a radio wave over a round trip distance of twice 121.5 nautical miles.

For any number stored in the memory registers, a direct relationship exists between that number and the time it will take to convert the number into a marker pulse. Thus, it can be precisely determined



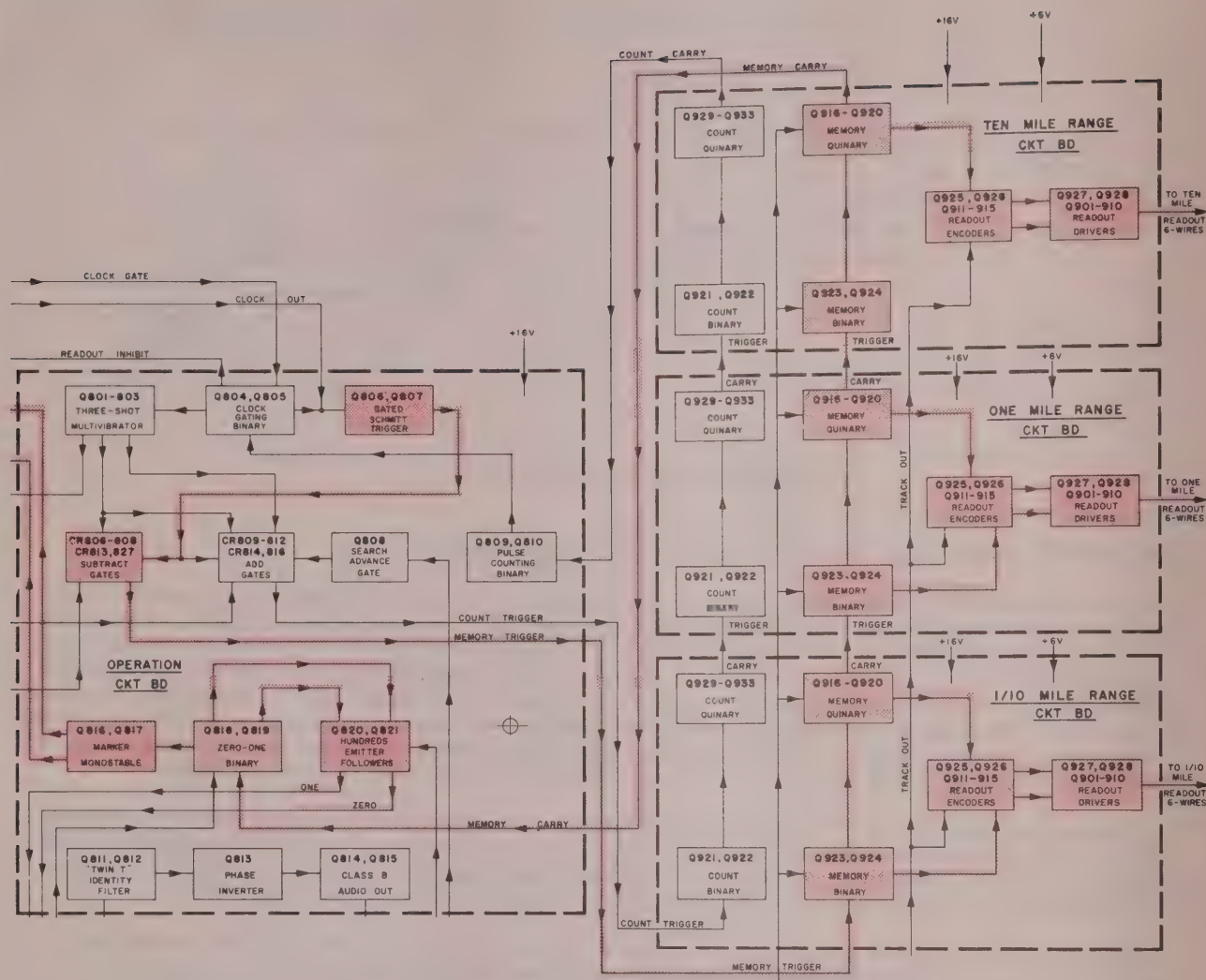


Figure 3-21. Memory Chain Block Diagram

input pulse (five complete clock time intervals) it will carry to the next counter. At that instant of time the stored number will have been reduced to 120.9. The addition of nine more clock pulses is required to shift the 0.1 mile register down to zero again. The number stored is now 120.0. The next pulse into the 0.1 mile register will cause it to carry to the 1.0 mile register. However, the 1.0 mile register is storing a zero and must carry on an input. Therefore, it will immediately carry to the 10 mile register, reducing its pulse-to-carry number by one. The stored number is now 119.9. 6-9-1 or 16 pulses have entered the 0.1 mile register to this time and 15 time intervals have elapsed.

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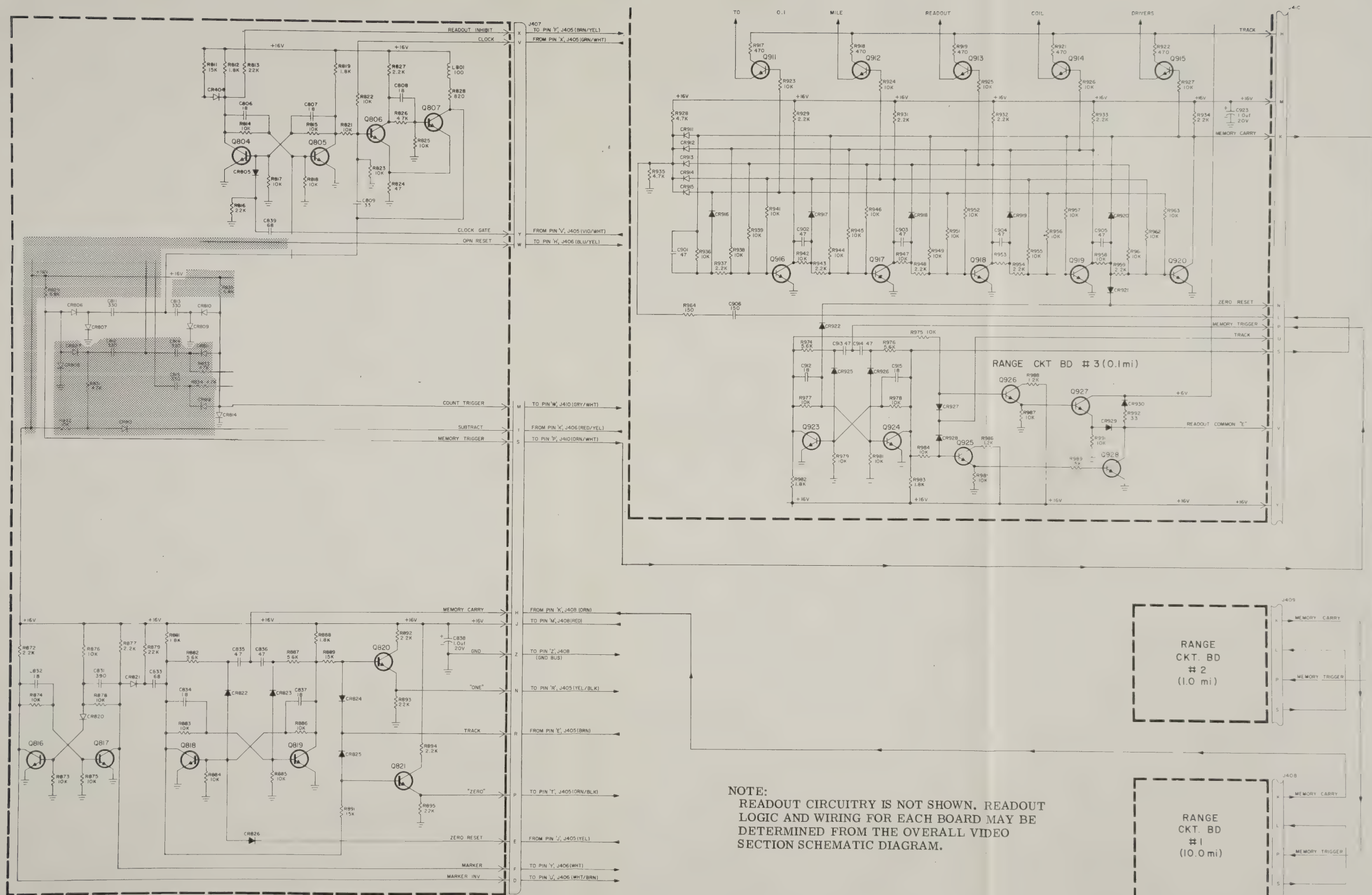


Figure 3-22. Memory Chain Circuit

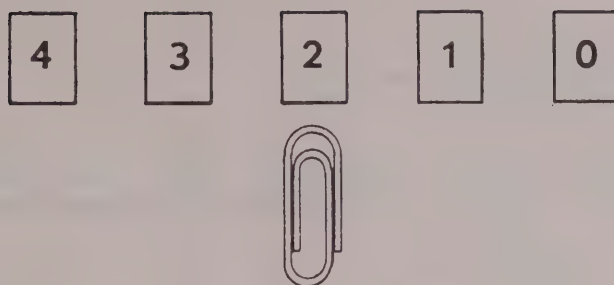


Figure 3-23. Shift Register Analogy

In Figure 3-23, the register is shown storing the number two. If we shift at some regular rate, say on ticks of a metronome, the third tick from the metronome would carry the paper clip from the zero position back to the left, or four position. If we called this event a marker condition, we might note that the time from the first tick to the third tick was two metronome intervals, and that position was converted directly into time. If we add two more ticks, the register will move from the four position to the two position.

One can see that whatever the position of the register, the addition of five shifts will restore it to its original position. For any register, regardless of its capacity, if the same number of pulses is added as it is capable of holding, then the register will be restored to its original state.

In the paper clip register, if we want to subtract from the number readout (and the time to marker), we simply add one pulse and shift the paper clip to the right one position.

If we want to add one to the number readout, we can add the capacity of the register less one, or in this case, 5 minus 1 or 4 shifts. This results in a net shift of one position to the left, or a larger displayed number.

THE THREE-SHOT MULTIVIBRATOR. This circuit generates the pulses that are used for addition and subtraction (see Figure 3-24). At the end of an interrogation cycle, when the clock gating binary is triggered by the 2,000th pulse into the count loop, the collector of Q-804 goes sharply to ground. This wave form is coupled through CR-804 and C-804 to the junction of R-809 and CR-803. The voltage at this point goes below ground, removing base drive from Q-803. This condition persists until current through R-809 charges C-804 to a positive voltage at the anode of CR-803. At that time current resumes through CR-803 into the base of Q-803, turning Q-803 back on. During the time Q-803 is off, its collector voltage rises to the +16 volt supply level. This places a charge on C-802, C-812 and C-814 (see Figure 3-25). When Q-803 turns back on, a negative going wave form is coupled through these three capacitors to CR-802 and to the two gates represented by CR-827 and CR-811. The wave form through C-802 removes base drive from Q-802 in a manner identical to what just happened to Q-803, and Q-802 turns off. Q-802's collector voltage rises towards the supply voltage. Current is coupled through C-805 and R-808 back into the base of Q-803. This provides regenerative action into Q-803 to

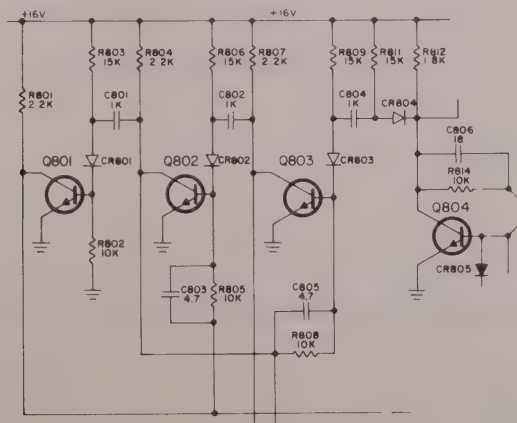


Figure 3-24. Three-Shot Multivibrator

whether that number represents a time delay that matches the time delay of the radio wave from the aircraft to the ground station and back.

The marker pulse is fed to the gate board to be compared in time with received returns. The gate board detects errors as the aircraft distance changes and commands an adjustment of the number stored in the memory chain so that the equipment can track the changing time delay. Refer to "Error Detection" under paragraph 3.4.7 "The Gate Board" for a detailed discussion of this process.

There are several aspects of the memory chain that require further discussion. In the previous example the stored number has been converted into a time interval or marker pulse by adding input triggers until all registers carried. The stored number has been destroyed by the conversion process. The number must be recreated before the next interrogation is made so that the marker can be generated again. How do the registers get back to the condition of 121.5? This is where the count loop comes into the picture. Each time the clock gate binary is triggered, it allows the gated Schmitt trigger to pass clock pulses. These gated pulses are directed to both the memory chain and the count loop. The pulse path to the memory loop is through C-811 and CR-806. The path to the count chain is through C-813 and CR-810 (see Figure 3-22). Remember that the count loop will stop the gated clock after it has counted 2,000 pulses.

In the example, the discussion was left at the 1216th input pulse as the memory registers carried from the 000.0 state. The new state of the memory registers would be 199.9 as all counters move to the next state possible to them. (The next state in sequence from zero for a decade or biquinary register is a nine, while the binary registers the only other state is a one.) Since the count loop is paralleled with memory chain, it has triggered on the same 1216 pulses from the gated Schmitt trigger as has the memory chain. The count loop will permit 2,000 - 1,216 or 784 additional clock pulses from the Schmitt before closing the gate. These 784 pulses will also be directed to the memory chain. The addition of these pulses will reduce the number of pulses-to-carry of the memory registers by 784. 1,999 - 784 equals 1215. The memory chain is now back to its original state for storing the number 1215. The count loop has reset the gating binary at the 2,000th count and the cycle has ended.

This cycle is repeated each time the transmitter interrogates. Between cycles, the memory chain remains on the stored distance number providing drive for the readouts. At 800 kc, it takes about 2.5 milliseconds to count 2,000 pulses and complete the cycle. With the unit in track Mode and interrogating 27 times per second, the time between interrogation cycles is 37 milliseconds. This leaves about 34.5 milliseconds out of every 37 milliseconds for readout drive.

ADDITION - SUBTRACTION. The process of reducing the number stored in the registers, or subtraction, is surprisingly the easiest to accomplish and understand. By now the reader probably suspects that the readout convention is backwards to what is normally thought of in a counting system. Conventionally, adding a pulse to a counter increases the number displayed. However, in the receiver/transmitter memory chain, what is actually being displayed is the number of pulses to carry for each register, or the number of additional inputs the register can hold before the register clears and begins again. Thus, the addition of one pulse to the memory chain will reduce the number displayed, the number of pulses-to-carry, and the time it will take to generate the marker pulse on the next interrogation cycle.

Since the operation of subtraction is accomplished by adding a pulse to the memory chain, it would seem that the operation of addition might be done by subtracting a pulse. However, this is not the case because the registers can move only in one direction, and to subtract a pulse would require that the registers transfer in a direction opposite from normal.

It was pointed out previously in the discussion on the memory chain that if 2,000 pulses are added to the chain, all registers will return to their original positions or states. If one pulse less than 2,000 (1,999) are added, the registers will run all the way around to their original state, less one, which is an apparent subtraction of one pulse.

Now, how does one add 1,999 pulses to the memory chain? Simply by adding one extra pulse to the count loop. Then, at the next interrogation cycle, the count loop, which already has one pulse, will allow only 1,999 clock pulses to be gated instead of the normal 2,000. This will result in a backward shift of the memory chain by one position, and an increase of one tenth of a mile in the distance number stored and displayed.

AN ANALOGY. Reference to a simple analogy might help to clarify the memory chain to the reader. Imagine a register with only five states. We might mark five squares in line on a sheet of paper as in Figure 3-23. Use a paper clip to indicate the condition or state of the register. The rules for moving the paper clip are as follows: (1) Adding a pulse shifts the clip from left to right, one position at a time. (2) On reaching the right end position, the transfer (a carry in this case) is back to the left end condition.

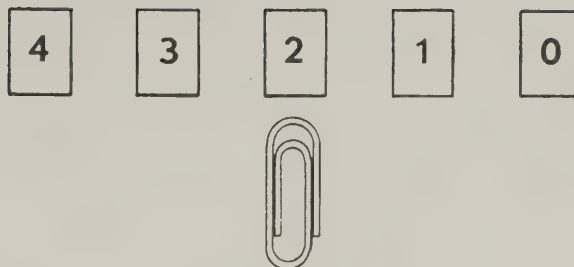


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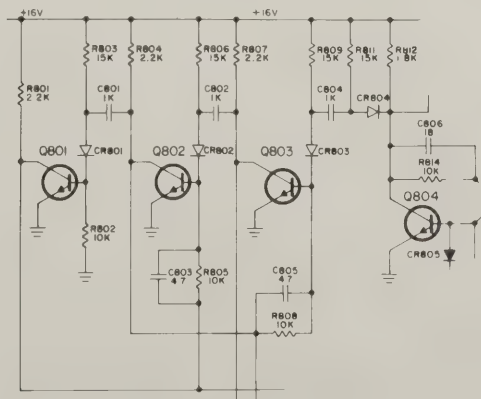


Figure 3-24. Three-Shot Multivibrator

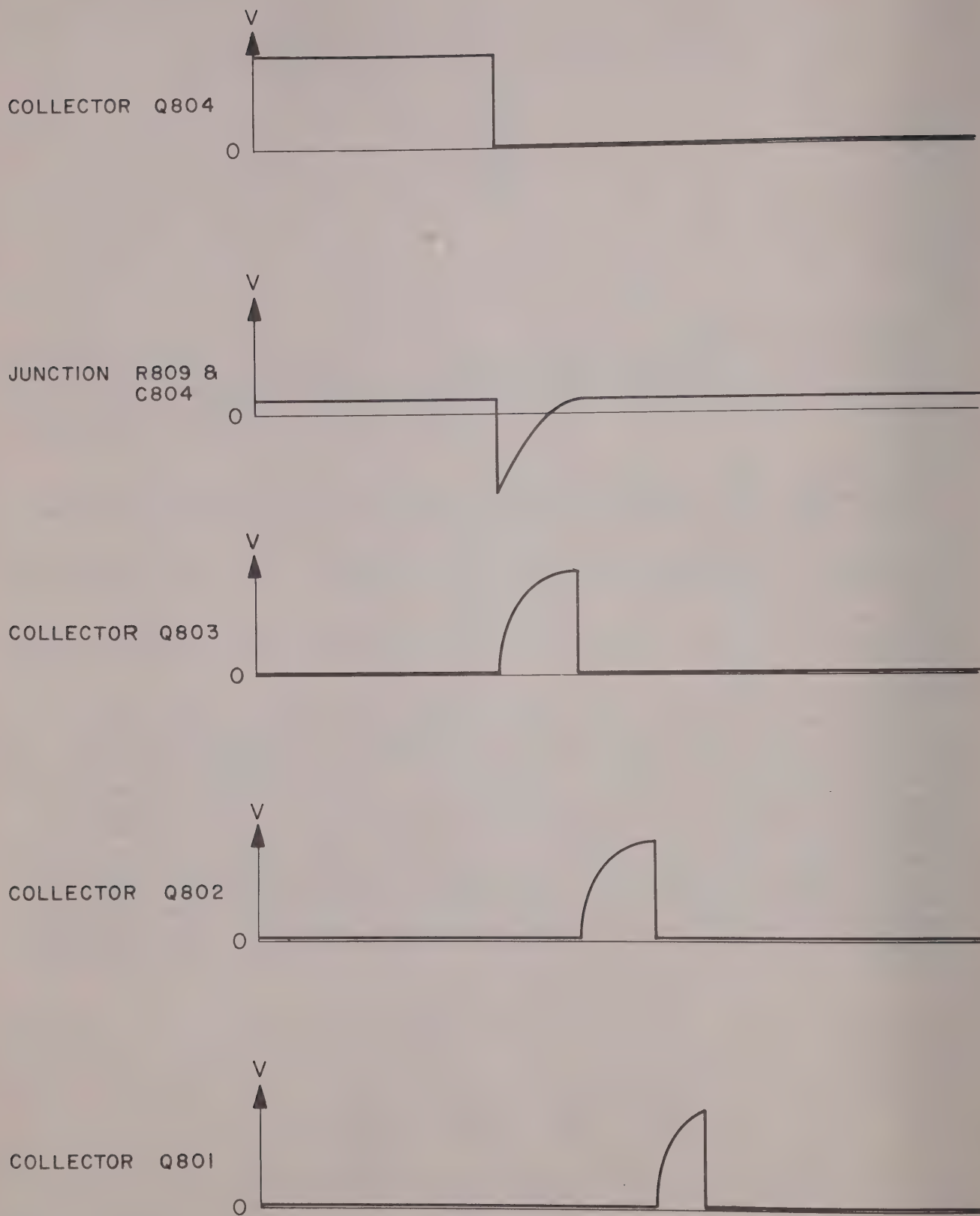
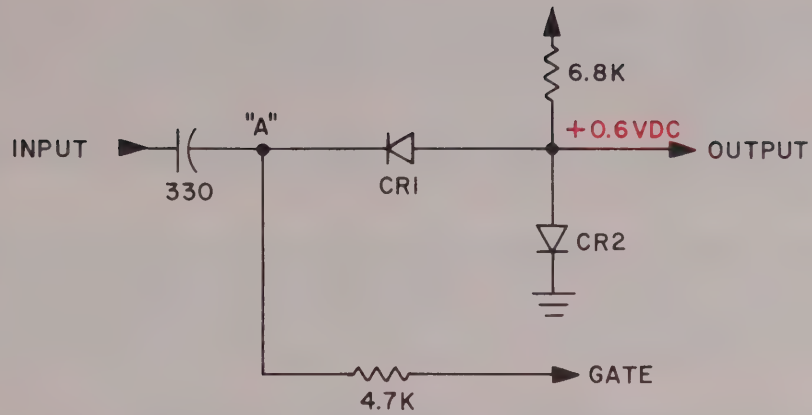


Figure 3-25. Three-Shot Multivibrator Wave Forms



DETAIL A. PULSE "AND" GATE SCHEMATIC

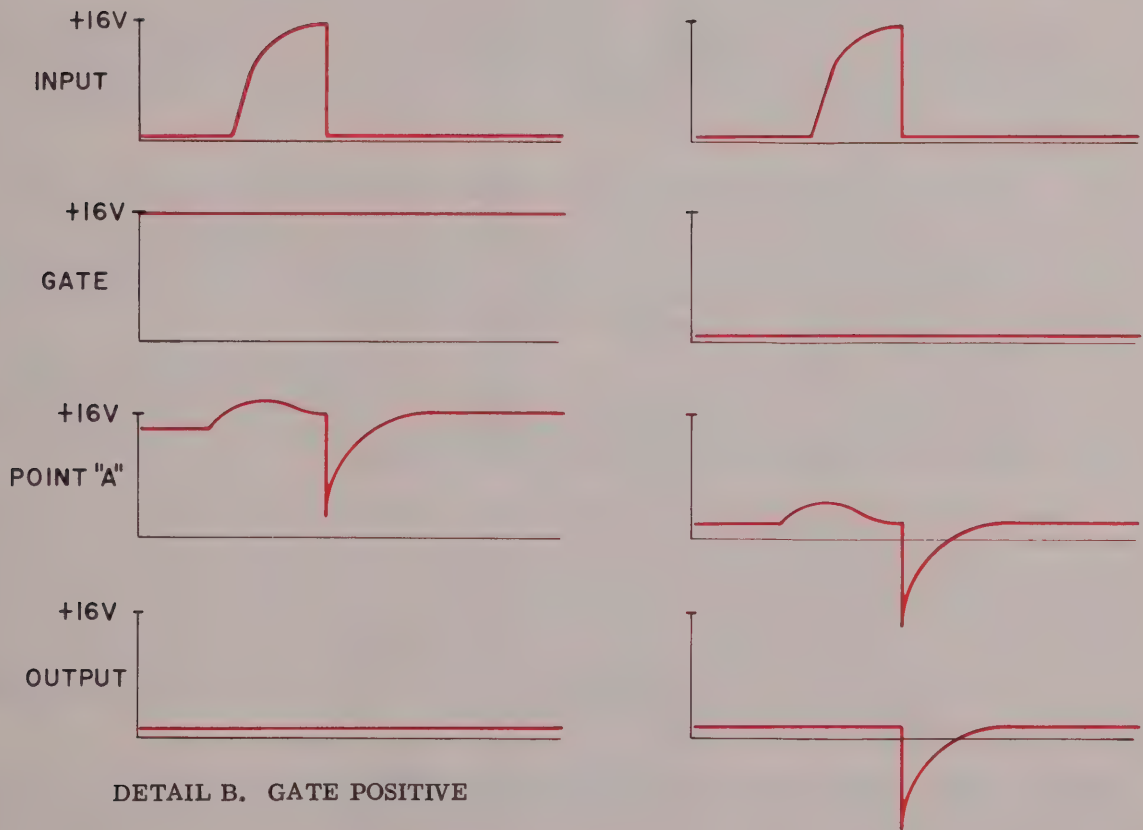


Figure 3-26. Pulse "And" Gate Diagrams

aid in turn on and provide a rapid transition in its collector wave form. Remember that as Q-803 started on, this caused Q-802 to turn off. While Q-802 is off, capacitors C-801 and C-815 are charged by the positive collector voltage. When R-806 charges C-802 so that the anode of CR-802 again becomes positive, current flows through this diode into the base of Q-802 and Q-802 begins to turn on reducing its collector voltage. This negative change in voltage is coupled through C-801 and Q-801 turns off due to loss of base current from R-803. The collector of Q-801 goes positive, and this voltage is coupled into the base of Q-802, aiding in its continuing turn on. Q-801 remains off for a time determined by R-803 and C-801, at which time current through R-803 turns it back on.

The circuit now will rest in this state with Q-801, Q-802 and Q-803 on as these transistors are held on by current from R-803, R-806 and R-809, respectively. At the start of a new interrogation cycle when Q-804 turns off, C-804 is allowed to charge up through R-811. At the end of that cycle when Q-804 turns back on, sequential pulses will appear at the collectors of Q-803, Q-802 and Q-801, in that order. These pulses are always present at the end of each interrogation cycle, whether they are used or not.

ADD-SUBTRACT GATES. The first two pulses out of the three-shot multivibrator are directed to the add or subtract gates. These are capacitor-diode circuits which will either pass or reject a pulse, depending on a dc input condition.

In Figure 3-26, a typical pulse "and" gate is shown. This is called an "and" gate because it requires both a negative going input wave form "and" a grounded gate condition to have an output.

When the gate voltage is higher than the dc voltage at the input terminal, the "A" side of the capacitor will be charged positive. The gate voltage will also back bias CR-1. If the input terminal is suddenly brought to ground, the resulting negative going wave form coupled through the capacitor to point "A" will be insufficient to cause conduction through CR-1. With CR-1 not conducting, no change will be seen at the output terminal.

However, with the gate grounded and a positive dc voltage at the input terminal, the "A" side of the capacitor will be charged negative with respect to the input side. CR-1 will be slightly conducting through the 4.7K and 6.8K ohm resistors. If the input terminal suddenly becomes less positive, point "A" will now become negative by a voltage equal to the change at the input terminal. This negative spike will forward bias CR-1, back bias CR-2 and be present at the output terminal. CR-2 serves to return the output terminal to near ground at the end of the negative spike.

In Figure 3-27, the add-subtract gates are made up of three of these "and" gates, two on the add side (CR-811 and CR-812) and one on the subtract side (CR-827). These gates are paralleled with CR-810 or CR-806 to provide an "or" function. This means for example that pulses can be fed to the memory trigger line either from the gated Schmitt trigger (Q-807) or from Q-803 in the three-shot circuit.

On an interrogation cycle, shortly after the transmitter is triggered, the Clock Gating Binary is set, allowing the Schmitt trigger to switch on clock pulses as previously discussed. This output travels through the isolation diodes CR-806 and CR-810 to the memory trigger line and the count trigger line. At the end of the cycle, the count loop resets the clock gating binary and stops the clock pulses. At that instant Q-803 in the three-shot circuit turns off, charging C-812 and C-814. When Q-803 turns on again, a negative-going spike may pass through CR-811 or CR-827, depending on whether gate permission is given in the form of a ground condition on the add or subtract lines. The add or subtract decision is made by the gate board during the interrogation cycle, and is made on the basis of a time comparison between the marker and the video returns.

If an add¹ condition exists, the add line will be at ground potential and CR-815 will be conducting, giving gate permission by holding the dc voltage at the junction of C-814 and CR-811 near ground. The negative spike caused by Q-803 will pass through CR-811 to the count trigger line. This will be stored by the count loop as if one clock pulse were already counted, and on the next interrogation cycle, the count loop would count only 1999 clock pulses before shutting off.

If the unit is in the search mode the second pulse out of the three-shot multivibrator (from Q-802) may be used. This is true only if a positive voltage exists on the advance line (Pin L, J-407). If this is so, Q-808 (Figure 3-23) will be turned on, opening both the CR-811 and CR-812 gates. In this case pulses from both Q-803 will be added to the count trigger line (a double addition). This increases the marker time by 0.2nm each interrogation cycle. If there were no search hesitation, the marker would search the full 200 mile range in 6.6 seconds². Search hesitation is discussed later, and due to this hesitation,

¹ Addition and Subtraction are referred to here as the indicated result of the readout, i.e. a subtraction would result in a decreased range number displayed. This results in a net backward shift of one count in the memory chain and an increased displayed number and marker time interval. (See previous sections for review of this.)

² Advancing 0.2 nm per cycle at the search interrogation rate of 150 per second give $0.2 \times 150 = 30$ nm per second. With 200 nm in a full search, $200/30 = 6.67$ seconds per search.

the search time will be longer than this when squitter is present.

At the time Q-801 turns off, the pulses from Q-802 and Q-803 have already been entered in the registers. This pulse from Q-801 travels down the operation reset line to the gate board and resets the binary circuits on that board to signify that if an add or subtract operation was commanded, it has now been completed.

The three range boards and most ³ of the operation board form a subsystem with several basic inputs and outputs.

INPUTS:

1. A continuous clock signal from the crystal oscillator.
2. A clock gate to start the count loop.
3. A subtract command.
4. An add command.
5. A double add command (search advance).
6. Track in (permission for readout drive).
7. Zero reset (resets all memory registers at the beginning of a new search cycle).

OUTPUTS:

1. A marker and marker inverted pulse (both from the same circuit).
2. An operation reset pulse (addition or subtraction operation completed).
3. Readout inhibit (disables the readout drive while the memory register is counting).
4. Readout drive to the four distance indicators in the indicator.

³ Part of the identity circuit is on the operation board and is discussed under Identity Circuit.

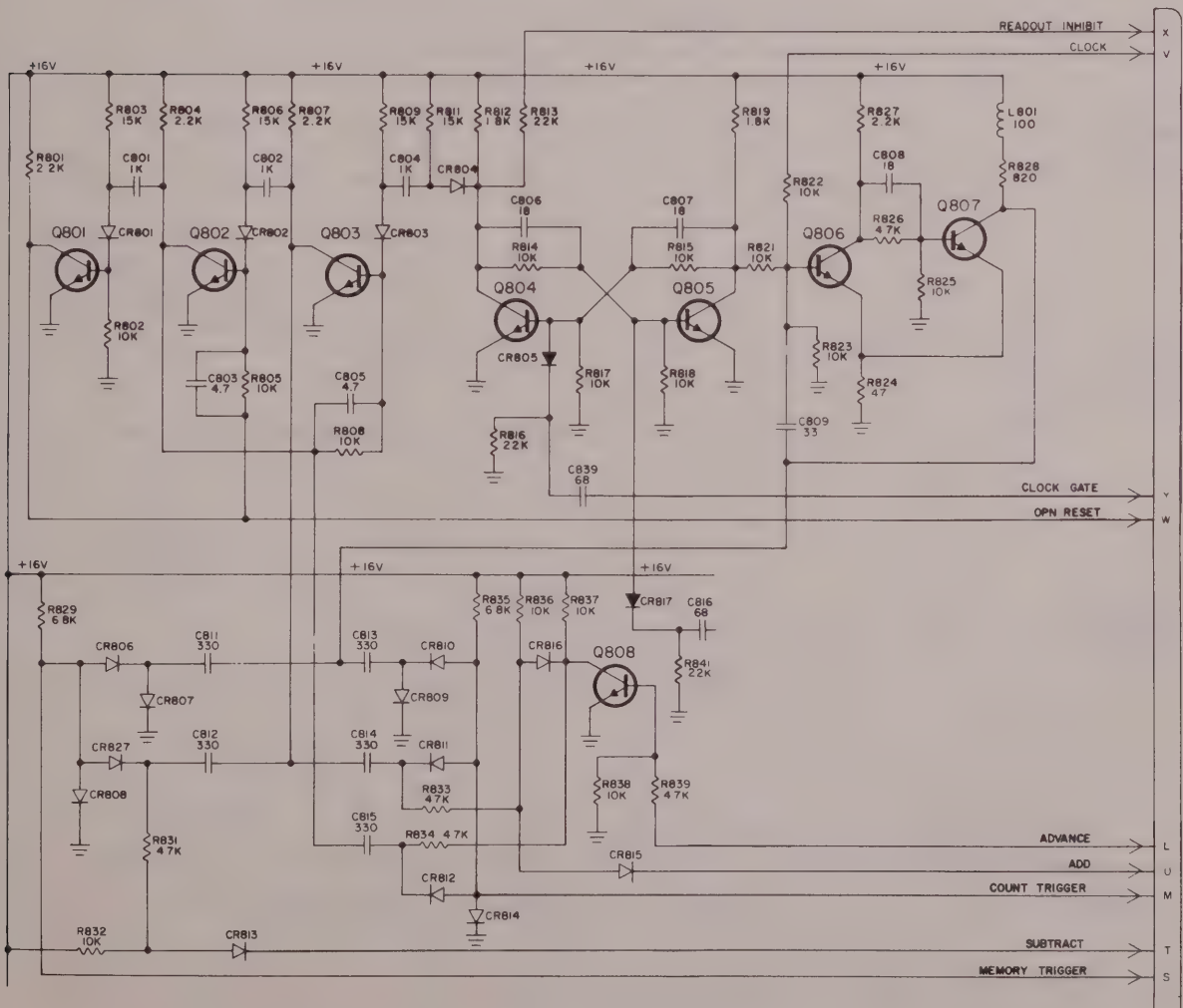
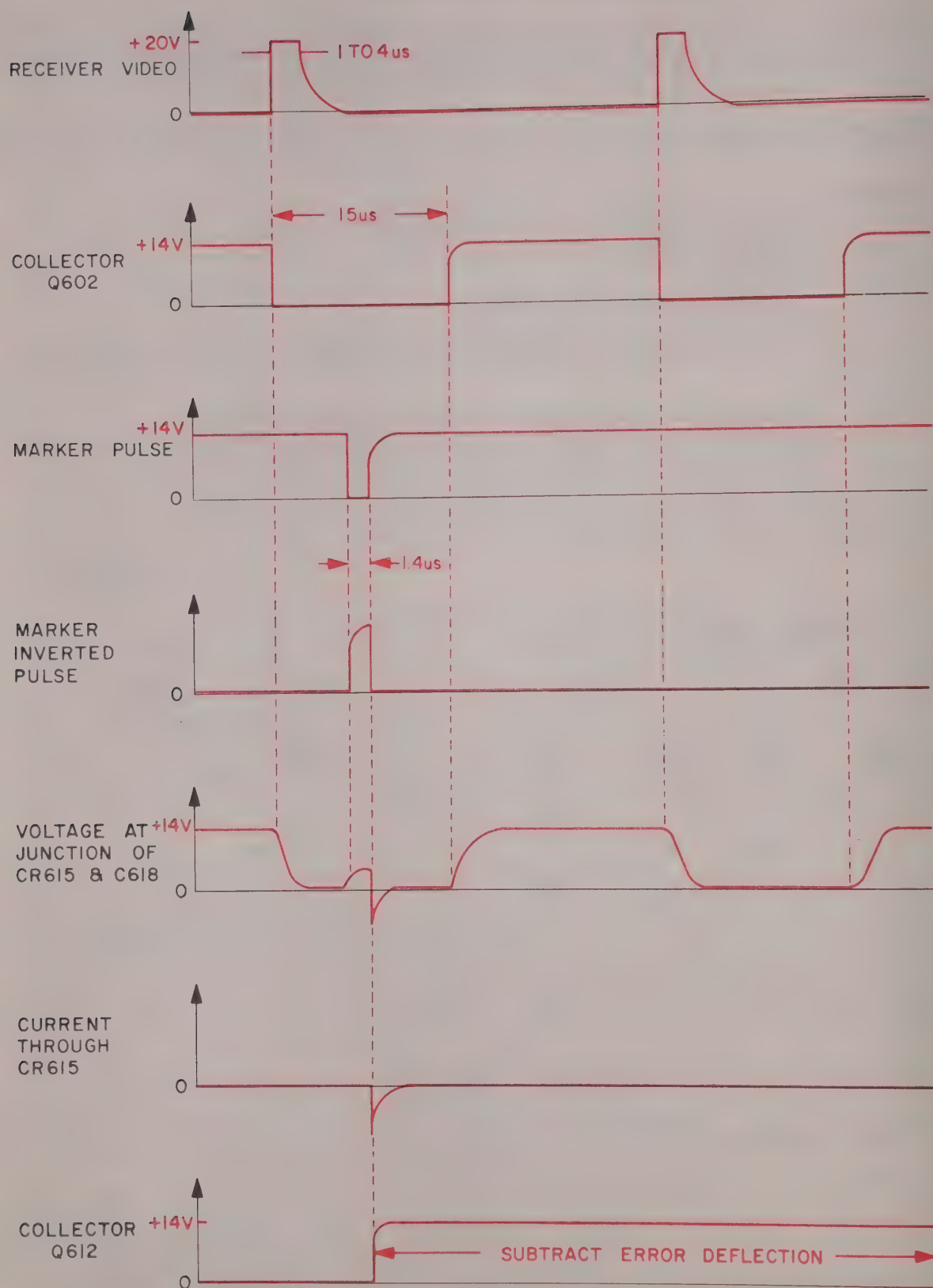


Figure 3-27. Add-Subtract-Advance Circuitry



NOTE: THESE WAVEFORMS ARE OF LOW DUTY FACTOR AND CAN BE SEEN ONLY BY STOBING WITH A DELAYED SWEEP OSCILLOSCOPE.

Figure 3-28. Subtract Error Detection

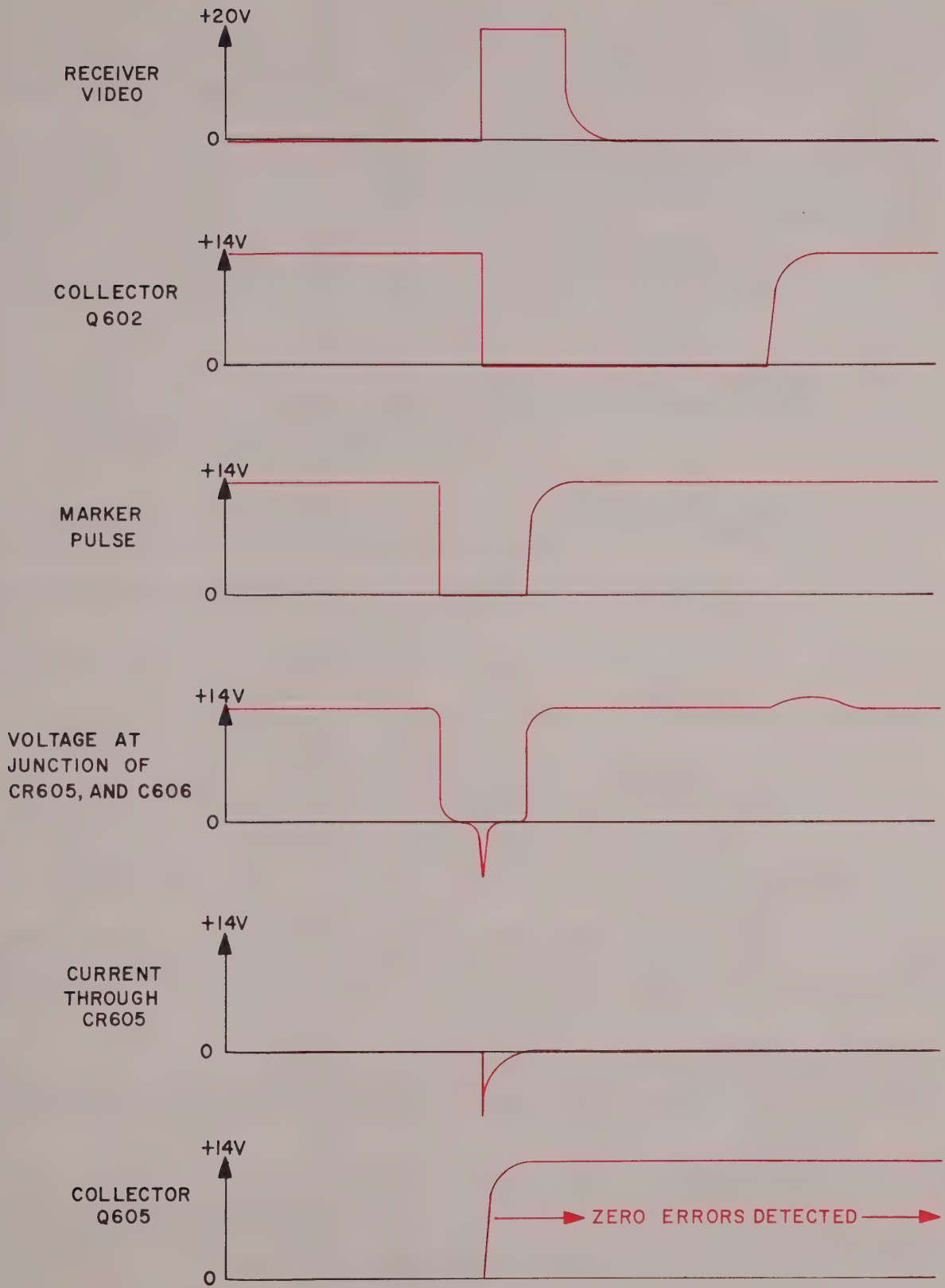


Figure 3-29. Zero Error Detection

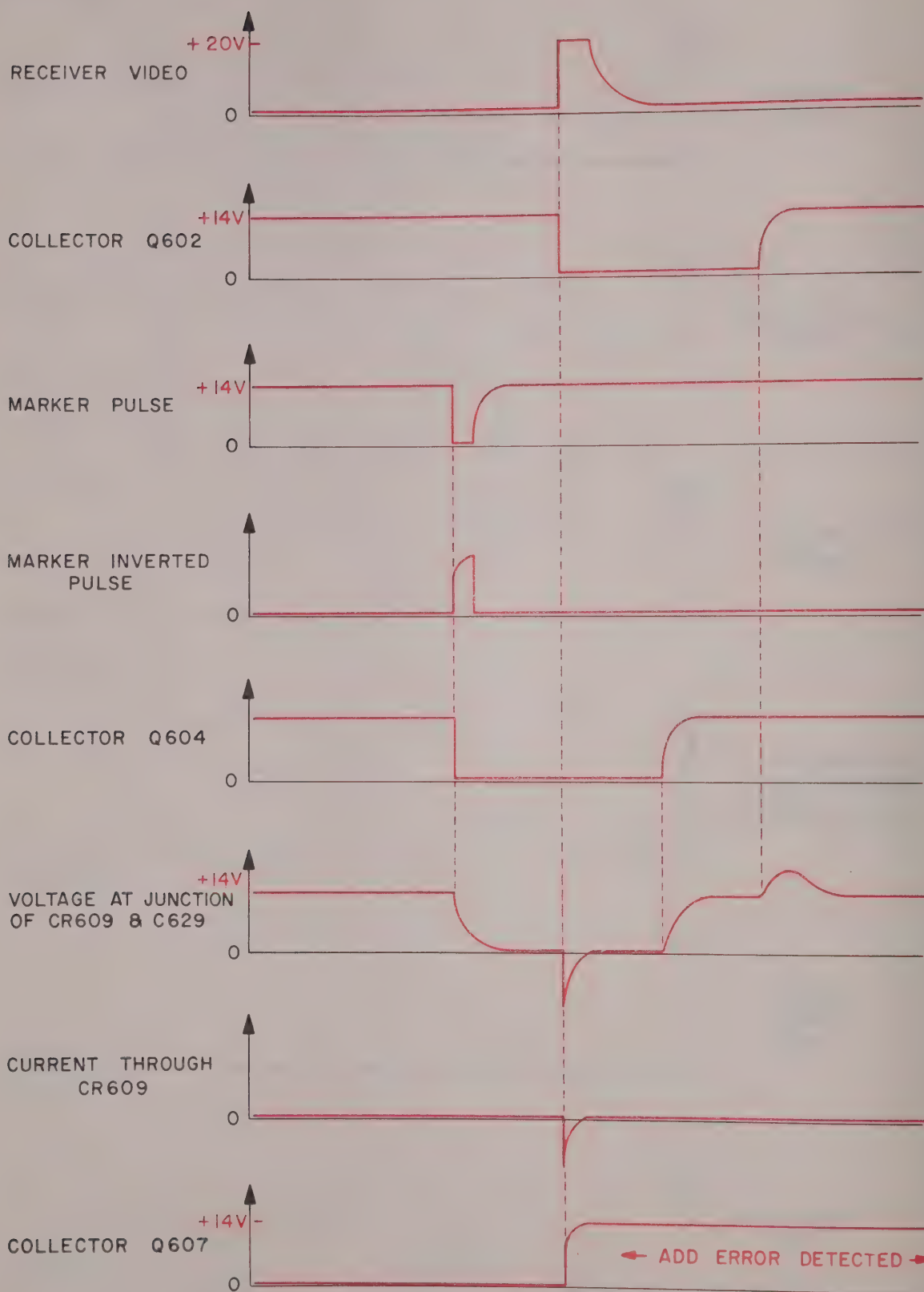


Figure 3-30. Add Error Detection

3.4.7 THE GATE BOARD.

The primary function of the gate board is to compare the received video reply with the marker pulse and determine if an error in time exists between the two. If a consistent error is detected, the gate board commands the operation board to add to or subtract from the stored distance number until the marker occurs in time coincidence with the received reply.

PRE- AND POST-GATE MONOSTABLES. The video signal from Q-310 in the I-F section triggers the pre-gate monostable Q-601 and Q-602. This is a "pulse stretcher" which is triggered on the leading edge of each positive video pulse and remains set for a time of 15 microseconds before resetting. Similarly, the leading edge of the positive marker inverted pulse triggers the post-gate monostable (Q-603 and Q-604) which also generates a 15 microsecond block.

These two monostables together with the CR-609 gate and the CR-615 gate form a phase detection circuit which determines the sequence of occurrence between the video return and the marker (see Gate Board Schematic and Block Diagram).

ERROR DETECTION. The possible sequences are:

1. Marker pulse following a video pulse by anywhere from 0.5 to 15 microseconds.
2. Marker pulse in coincidence with video pulse (marker leading edge prior to video pulse leading edge by 0.1 to 1.4 microseconds).
3. Marker pulse preceding a video pulse by 0.5 to 15 us.

Sequence 1 is considered to be a subtract error, as the marker appeared after the video return. This would tend to indicate that the distance number stored was too large and should be reduced to shorten the time between interrogation and marker generation.

Sequence 2 is a zero error condition and indicates that the unit is tracking the return accurately and no correction to the distance number is necessary.

Sequence 3 is an add error condition and indicates the time-to-marker was too short. To correct this error, the distance number must be increased.

On subtract error condition, the video pulse triggers the pre-gate monostable which enables the CR-615 pulse "and" gate for 15 microseconds.

If a marker inverted pulse is applied to the gate through C-618 during this time, the negative going trailing edge can pass through CR-615 and turn off Q-612, causing an output from the subtract error detector (see Figure 3-28 and the block diagram). Q-611 and Q-612 form a binary circuit which is set by a subtract "and" gate output and reset by the positive pre-range pulse through R-654 at the beginning of the next interrogation cycle. CR-616 and CR-601 provide isolation between the triggering wave forms and the control wave forms.

During the short time (1.4 microseconds) that the marker voltage is at ground potential, a high speed gate, CR-605, is enabled through R-624 and CR-606. If the pre-gate monostable is triggered by a video pulse during this time interval, the negative going collector wave form from Q-602 is passed by C-606 through CR-605 and sets Q-605 in the zero error binary (see Figure 3-30). (Again reset by pre-range at the start of the interrogation cycle.)

To detect an add error, the marker inverted pulse triggers the post-gate monostable and Q-604 remains on for 15 microseconds, opening the CR-609 gate by way of CR-607. If a video pulse triggers the pre-gate monostable during this "open gate" time, the negative going collector voltage wave form from Q-602 passes through C-629 into the base of Q-607 causing an output from the add error detector.

These three error conditions create a narrow time zone or "aperature" that encloses the marker pulse by 15 microseconds in either direction (30 microseconds total width). A video pulse that differs in time by more than 15 microseconds cannot meet any of the three conditions and is ignored by the gate board as having too large an error to be a reply to an interrogation. A video pulse falling within the aperature is identified as a "return" as it is close enough in time (distance) to be considered a reply to an interrogation.

A return is recognized when one of the three error detectors has been triggered, i.e., whenever either Q-612, Q-605, or Q-607 is turned off. Current will flow through R-664, R-663 or R-665 to the "Returns" output (Pin W, J-406).

ADD ERROR OPERATION. It should be noted that from this point the discussion will be limited to an add

error operation as the circuit is symmetrical and a subtract error is treated in an identical manner by the other half of the circuitry.

Due to the semi-random occurrence of replies from the ground station, an error detected only once is not acted on. Any one aircraft's interrogations may result in from 30 to 90 percent replies from the ground station, depending on the number of aircraft using that station. Thus, some pulses falling in the return aperture may be ground station replies to other aircraft. These pulses will randomly initiate add and subtract errors. Valid replies are separated from random error triggering by accumulating several errors by integration to determine if the error occurs consistently.

All error detectors are reset by a positive pre-range pulse (Pin V, J-406) slightly before the transmitter fires at the beginning of each interrogation cycle. An error will be detected in the first 2.5 milliseconds of the cycle. (Example: If the unit was tracking at 100 miles, the marker would occur approximately 1.25 milliseconds after the pre-range pulse. Error detection must occur within 15 microseconds of the marker pulse). Once set, the error detector will not be reset until the pre-range pulse at the start of the new interrogation cycle. At the track prf of 27 pulses per second there is about 37 milliseconds between interrogations. An oscilloscope sweep slow enough to include several interrogation cycles would look similar to Figure 3-32, on an add error condition at the points noted.

In Figure 3-31, the third interrogation did not receive a reply, illustrating, a 3/4 or 75% return ratio. Note that during an add error, the collector of Q-607 is at a relatively high dc average voltage, and charges C-613 through R-638 and CR-611. If an add error is not present, C-613 is discharged through R-637 and the collector of Q-607 to ground.

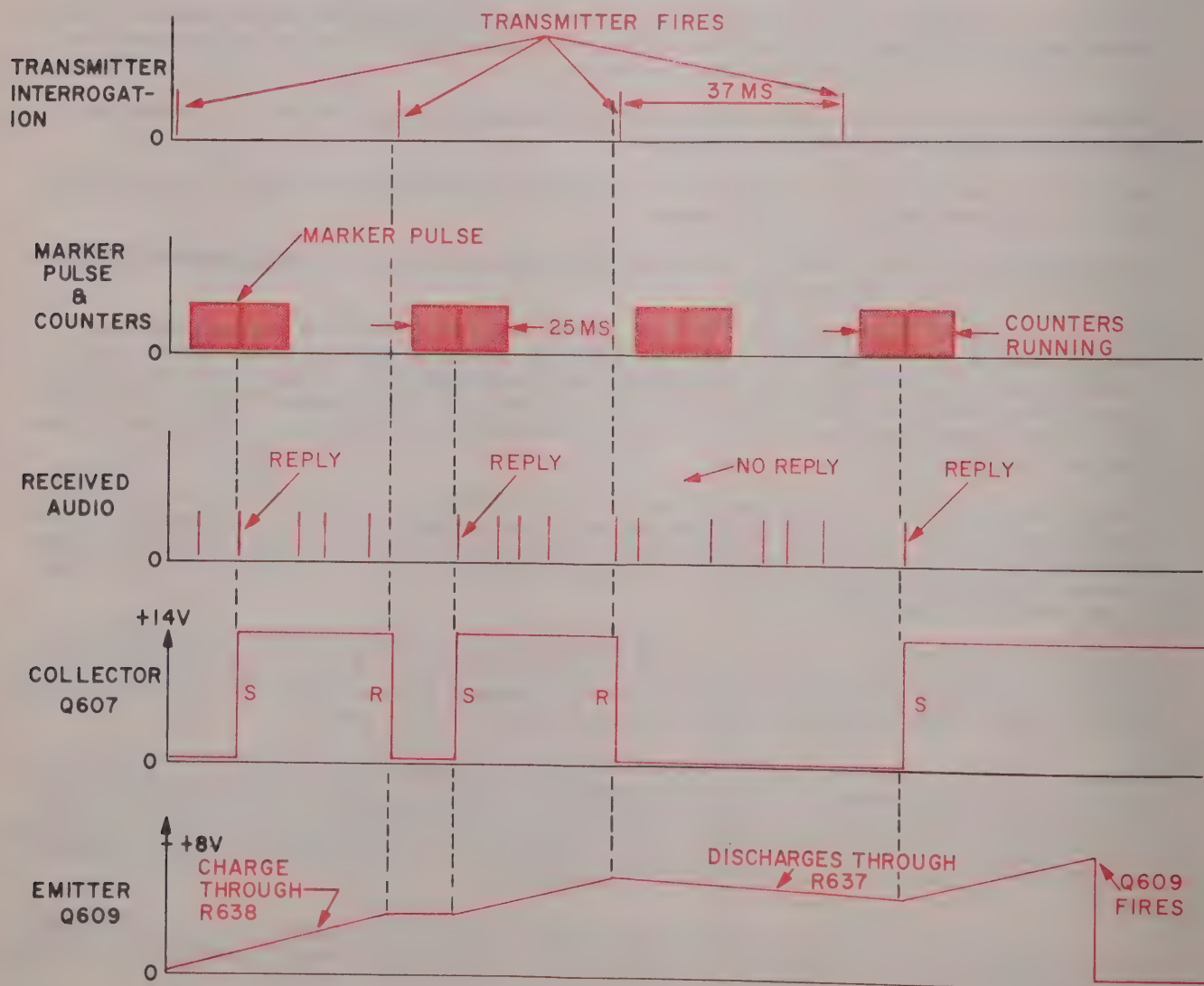


Figure 3-31. Add Error Integration

Two other paths may discharge C-613. These are through R-641 or R-642 when either the subtract error detector or the zero error binary, respectively, is set. Either of these two conditions casts doubts on an addition operation and requires an accumulation of more add errors before the firing voltage of Q-609 is reached. The total effect of these cross connections is that only a few consistent add errors are required to produce an addition operation, but as the errors become less consistent, the unit tends to wait longer before acting. This prevents jittering of the distance indication while tracking.

Q-609 is a unijunction transistor that has the characteristic of being essentially an open circuit until an emitter voltage (Pin 1) of 8 to 12 volts is reached. At that voltage the transistor will "Fire", essentially connecting C-613 to R-643 and creating a positive pulse at Pin 2. This pulse passes through R-674 to the base of Q-613 and "Sets" the add binary (Q-613, Q-614) by turning on Q-613. This places a ground on the add line to the operation board and results in an addition operation as discussed in a previous section.

Since Q-614 is off when Q-613 is on, its collector will be positive and current will flow through R-694 and CR-627 to the "Gates" line (Pin F, J-406), triggering the velocity circuit in the indicator. This informs the indicator that a distance change of 0.1 nm is in process. (See paragraph 3.7, Indicator.) On completion of the addition, an operation reset pulse (Pin H, J-406) from the three-shot multivibrator resets the add binary by turning on Q-614 through R-677.

TO - FROM BINARY. The To-From Binary, Q-615 and Q-616 serves to "remember" the direction that the aircraft was going on the last addition or subtraction. If the unit is tracking outbound, the previous operations all will have been additions, and Q-616 will have been turned on by the first pulse from Q-609 through R-681.

With Q-616 on, C-615 is essentially connected in parallel with C-616 on the subtract error integrator. C-615 can now charge through CR-619 and the grounded collector of Q-616. On the add half of the circuit, C-614 is disconnected from Q-609 as Q-615 is off and CR-618 is reversed biased, preventing C-614 from charging. This has the effect of more than doubling the time constant of the subtract error integrator and increasing the number of errors that must be detected before a reversal of direction is permitted. If the aircraft reversed its direction relative to the ground station, Q-610 would eventually fire. Q-615 would turn on, switching the binary into the "To" state and connecting C-614 to the add integrator and disconnecting C-615 from the subtract integrator.

Thereafter, subtraction will continue in a manner similar to addition in the above discussion.

The To-From Binary also serves to provide interpolation direction during a loss of signal condition.

INTERPOLATION. Under normal conditions, the pulse rate to the gates line informs the indicator of the relative velocity of the aircraft with respect to the ground station. At 600 knots, the tenth mile rate of change will be 100 per minute. The indicator converts this pulse rate into a velocity voltage and also converts this velocity voltage back into a pulse rate. The interpolate pulse is continuously fed back to the gate board (Pin L, J-406) but is not normally used. These pulses are synchronized to the gate line pulses so that they occur at approximately the same time and rate as the error command additions or subtractions. Should returns momentarily be lost due to ground station identity or because of some blockage in the line of sight radio path, the interpolation pulses are allowed to substitute for pulses from the error integrators. This allows the unit to continue tracking in the same direction and at the same rate as it was before signal was lost, maintaining the continuity of the distance display.

The interpolate pulses from the indicator are applied to R-667 and R-668. The interpolate hold line (Pin J, J-406) is normally at ground potential by command of the initiation board. The current through R-667 and R-668 due to the positive interpolate pulses is shunted by diodes CR-622 and CR-623 to ground. If interpolation is called for, the interpolate hold line will rise to a positive voltage of about +14 volts, back biasing CR-622 and CR-623. With these diodes now back biased, the interpolate pulse is still shunted to ground by either CR-625 or CR-626, depending on the state of the To-From Binary. If the last operation from the error integrator was a subtraction, then the To-From Binary will be in the "to" condition as Q-615 would have been turned on by a pulse from Q-610. CR-625 will shunt the pulse current from R-667 to ground through the on Q-615. Q-615, however, will be off and its collector will be at a high positive voltage, back biasing CR-626. The pulse current from R-668 will be allowed to pass through CR-624 and R-689 into the base of Q-618, setting the Subtract Binary. A subtraction operation will thus be carried out by the interpolation pulse in the same manner as if it has been commanded by the Q-610 Subtract Error Integrator.

STAND-BY CIRCUIT. The stand-by circuitry of the receiver/transmitter is located on the gate board. It operates by sensing the average decoded squitter rate received from the ground station (typically from 700 to 2700 pps). If the average rate drops below about 300 pps, it indicates the reception patch is sub-marginal and the transmitter is shut off. The stand-by circuit prevents useless transmitter operation

when the ground station is not being received, when out of range or tuned to an inactive channel. Another advantage realized is that of providing a warm-up time delay. This insures that the high voltage pulses are not applied to the transmitter tubes until their cathodes have warmed up sufficiently to take pulse currents without damage.

At initial turn-on, no mixer injection will be developed in the R-F unit until the tubes in the multiplier chain have warmed up. When these tubes reach their operating temperature, the received signals will produce video inputs to the gate board, activating the stand-by circuit and allowing modulator high voltage pulses to be initiated.

Theory of operation is as follows: Each decoded video pulse from the I-F Section (Pin X, J-406) triggers the Pulse Stretcher (Q-619 and Q-620) by turning on Q-620 through R-698. Q-619 turns off, holding Q-620 on through R-701, and remains off until C-621 can charge back up through R-696, turning Q-619 back on and Q-620 off. For each received video pulse, a positive voltage block about 150 microseconds wide occurs at the collector of Q-619. C-622 is charged by current through R-704 and CR-630 during the voltage block and discharged by R-703 in the absence of pulses. In this way, this average voltage on C-622 is proportional to the average rate of video pulses.

In the absence of received pulses, C-622 will be completely discharged to ground potential and Q-621 in the Stand-by Schmitt Trigger will be off. Q-622 will correspondingly be on, holding the stand-by line (Pin E, J-406) clamped to near ground potential. If the received squitter rate is greater than 300 pps, C-622 will charge above about 2 volts and Q-621 will snap on, turning Q-622 off which removes the ground condition on the Stand-by line.

The stand-by line connects to Pin K, J-405 on the initiation board where Q-512 is inhibited by CR-509 while the Schmitt trigger is in the stand-by state, preventing initiation pulses from reaching the Pulse Modulator.

While in the track mode, the standby function is disabled by an input to the gate board through Pin B, J-406 and R-708. Q-621 is forced to remain on, allowing continuous transmitter operation while the unit remains in track.

It is sometimes convenient during servicing to override the standby function so that an L-band signal generator is not required for transmitter checks. This can be done by disconnecting one end of the standby line (the brown-white wire between Pin K, J-405 and Pin E, J-406).

3.4.8 INITIATION BOARD.

PRF GENERATOR. The pulse repetition frequency of the receiver/transmitter is derived from a Unijunction Relaxation Oscillator, Q-502. This oscillator can run at either of two rates; approximately 28 cycles per second in track mode and 140 cycles per second during search mode. (See Figure 3-32.)

First, consider operation in the track mode. Current from the +16 volt bus flows through R-504 discharging C-503 and charging C-502. The Search-Track Binary will be in the "track" state with Q-519 turned on (see Figure 3-32). CR-510 will not conduct during any part of the cycle and thus is not a consideration in this mode. The same can be said for CR-511, as it is always reverse biased except during zero reset or when the channeling motors are running. No current can flow through R-505 or CR-502 and the discharge rate of C-503 is determined only by R-504. The voltage at the unijunction emitter will rise to its peak point voltage or trigger level (about 10 volts, depending on the device and the prf adjust setting), turning Q-502 on. When this happens, C-502 will be rapidly discharged and C-503 rapidly charged until the emitter voltage is reduced to two volts or less, Q-502 will then turn off and the cycle will begin to repeat. While Q-502 conducts, a short, positive spike appears at R-507 and is coupled through C-504 into the base of Q-503, a pulse amplifier.

In the search mode, Q-519, is turned off, forward biasing CR-510 and providing an additional current path to C-503. This path includes R-571, CR-510, R-506 and R-505 in series. The discharge rate of C-503 is more than quadrupled, with a corresponding increase in oscillation frequency.

A prf adjustment (R-511) is provided which adjusts both the search and track rates. Normally this setting is adjusted for track prf. The search prf is largely determined by the ratio between resistors R-504 and R-505. Adjusting the track prf changes the search prf in a proportional manner.

PULSE AMPLIFIER AND INVERTER. The first pulse amplifier, Q-503, is normally off as there is no dc input to its base. Its collector voltage will rest at about +14 volts except during the short time Q-502 is conducting. When Q-502 fires, current through C-504 will momentarily saturate Q-503, producing a ground potential condition at its collector for roughly five microseconds. This is coupled to the synchronizing gate and to Q-504 through R-513. Q-504 turns off and "inverts" the ground condition, producing

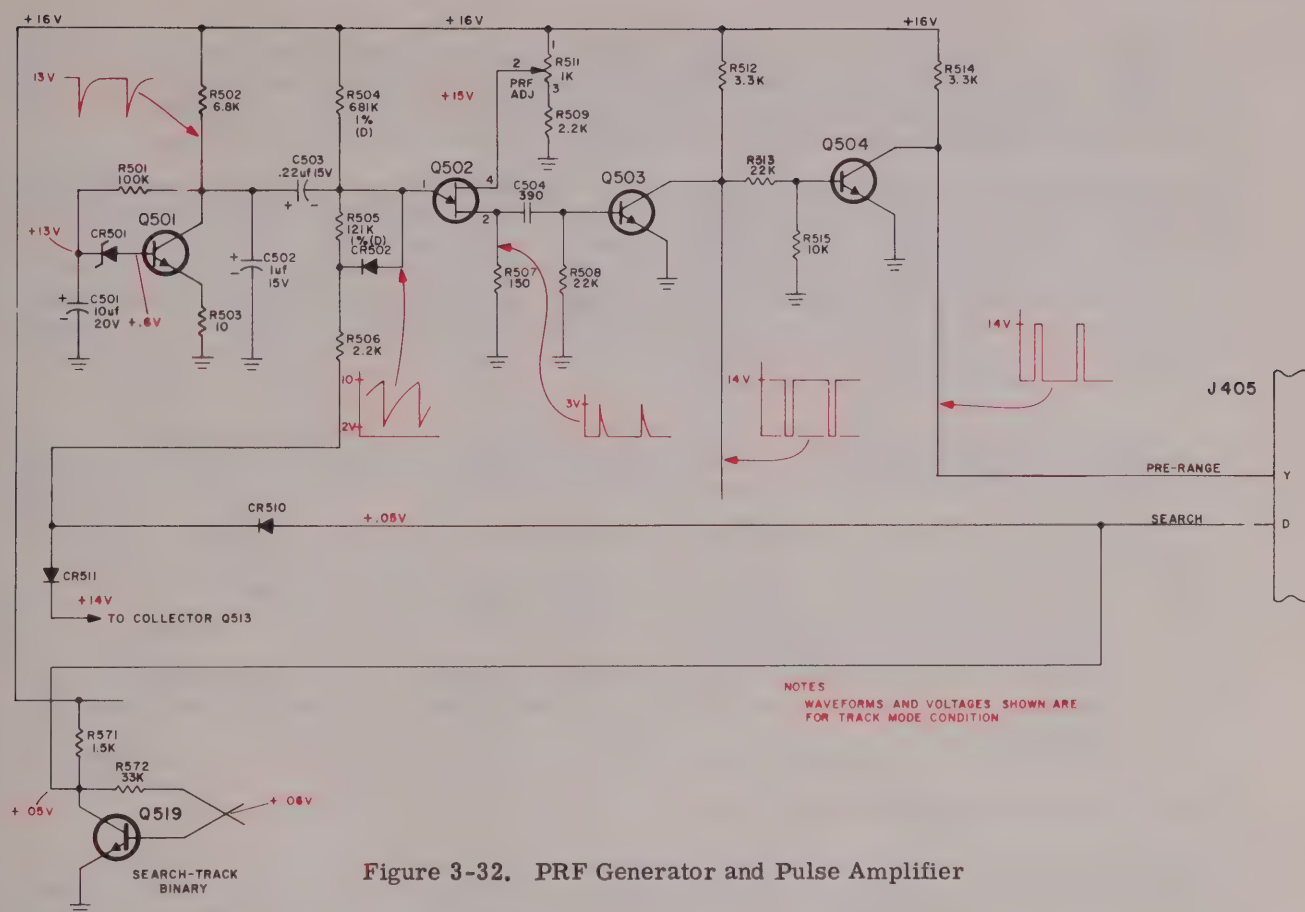


Figure 3-32. PRF Generator and Pulse Amplifier

a five microsecond positive pulse. This positive pulse is the pre-range pulse to the gate board which resets the error detectors before each interrogation cycle.

NOISE GENERATOR. The interrogation rate of the receiver/transmitter is deliberately "jittered" (made semi-random) by injection of a small noise voltage into the prf generator. The noise source is a 12 volt zener diode, CR-501. Zener diodes will produce noise when operated at a low current level in the "knee" or beginning of the zener region. Q-501 serves to hold CR-501 in the low current region and to amplify the noise signal. At initial turn-on, Q-501 will be off and its collector voltage nearly at +16 volts. C-501 will charge through R-501 until the cathode voltage of CR-501 becomes large enough that the zener begins to conduct. The small zener current causes Q-501 to turn on and reduce its collector voltage to the point at which the current through R-501 is just sufficient to maintain conduction of the zener and the transistor. The small, random, voltage fluctuations at the collector of Q-501 are coupled through C-503 and are superimposed on the rising voltage wave form at the emitter of Q-502. These fluctuations cause the emitter wave form to reach the triggering level of the unijunction earlier or later than it would without the noise voltage, producing a variation in pulse spacing. This variation is typically from 3 to 10% of the pulse spacing with 2 millisecond of jitter, for example, in a 37 millisecond track pulse spacing.

A certain amount of randomness of interrogation rate is desirable to prevent several airborne units, all on the same channel, from phasing in and out with each other, as pointed out in Section II.

CLOCK GENERATOR. The 1.617 mc Oscillator, Q-507, is crystal controlled and is the primary time and distance standard of the receiver/transmitter. The crystal is specified to .01% and is operated near series resonance in a modified Pierce configuration.

The oscillator is coupled directly to a trigger binary (Q-508, Q-509) which divides the sinusoidal input by two, producing an 808.786 kc square wave, low impedance output. L-501 serves to tune out the extra capacitive load in the collector circuit of Q-509.

The output is continuous and is applied to both the synchronizing gate and to the gated Schmitt trigger located on the operation board.

SYNCHRONIZING GATE. The synchronizing gate (CR-507) is a pulse "and" gate which allows triggering

of the zero mile delay monostable on the first negative going clock cycle following the turn on of Q-503. This ensures that the transmitter interrogation will always occur in a fixed phase relationship with respect to a clock cycle to initiate an interrogation cycle. Stated differently, the prf generator gives permission for the next occurring clock cycle to initiate an interrogation cycle.

ZERO MILE DELAY MONOSTABLE. This circuit (Q-510, Q-511) triggers the SCR Driver (Q-512) on the leading edge of the first clock pulse allowed through by the synchronizing gate. It remains triggered for 67.8 microseconds and then resets. As it resets, the clock gate line (Pin V, J-405) carries a negative going wave form to trigger the clock gating binary on the operating board. The timing of this circuit is adjusted so that the count loop and memory chain begin triggering at the exact time that a decoded reply pulse would come out of the I-F section if the unit were interrogating a ground station at a distance of 0.0 nautical miles. If the stored distance number in the memory chain is zero miles, the marker will occur in time coincidence with the reply pulse.

Two differences between the zero mile delay monostable and the other monostables in the unit contribute to its stability. It operates at only +6 volts due to voltage drop through R-529; and CR-508 is used as a temperature sensitive resistance, compensating timing variations due to changes in temperature.

The following items determine the total delay required of the zero mile delay monostable:

1. The delay between triggering and firing SCR-201, about .5 microseconds.
2. A delay through the pulse forming network from SCR firing to the 50% leading edge of the first modulation pulse of 3 microseconds.
3. The standard pulse separation of 12 microseconds between the first and second pulse.
4. The delay of the ground station of 50 microseconds between reception and transmission of a second pulse.
5. A delay of 2.3 microseconds through the I-F amplifier due to its band pass characteristics.

These delays are illustrated in Figure 3-33.

SCR DRIVER. Q-512 operates as an emitter follower of the voltage block on Q-511's collector. This positive wave form is coupled through R-543 and C-517, providing a fast rise trigger to the gate of SCR-201 in the modulator section. If the stand-by line is at ground potential, CR-509 shunts base drive to Q-512, preventing it from following Q-511 and inhibiting modulator triggering. (Refer to Stand-By Circuit" under paragraph 3.4.7 The Gate Board.)

SEARCH - TRACK BINARY. The Search-Track Binary (Q-519 and Q-520) is placed in track mode (Q-519 on) by a positive pulse from Q-518, the track decision unijunction. Once in track, a positive going transition from Q-513 (turning off) coupled through C-521, CR-514, R-551 into the base of Q-520 is required to trigger to the search state.

The Search-Track Binary controls the following functions:

1. The interrogation rate of the prf generator.
2. The track power driver (Q-521, Q-523).
3. The time constant of the last return delay generator (Q-524, Q-525, Q-526).
4. The advance line (Pin C, J-405) to the operation board (Q-808).
5. The velocity clamp in the indicator.
6. The stand-by circuit on the gate board.

The function of CR-519 and C-526 is to force the unit into search mode when power is initially applied. This is done by clamping the collector of Q-520 to the discharged C-526 so that Q-519 must turn off. As C-526 charges up through R-577 it back biases CR-519 and does not further influence the operation. This prevents the search-track binary coming on in its track state, locking out the standby function before the transmitter warmed up.

TRACK POWER DRIVER. This circuit controls the voltage on the track line (Pin E, J-405) to the memory register readout circuits. If Q-523 is turned on, this line is at ground potential and no drive is permitted. Thus, if the unit is in search mode, current through R-578 from the search-track binary into Q-521 will hold Q-523 on. A current into the base of Q-521 from the readout inhibit line (Pin F, J-405) will also cause the track line to be grounded. This condition occurs during every interrogation cycle while the counters are running, as mentioned in paragraph 4.4.6 "The Memory Chain". If Q-523 is off, a positive voltage appears on the track line due to current through R-402, which is physically located between the +16 volt line and the track line (Pins M and U of J-410). This gives permission for all readout drivers to operate.

RETURNS RATIO BINARY. The Returns Ratio Binary (Q-516, Q-517) is always reset by the pre-range

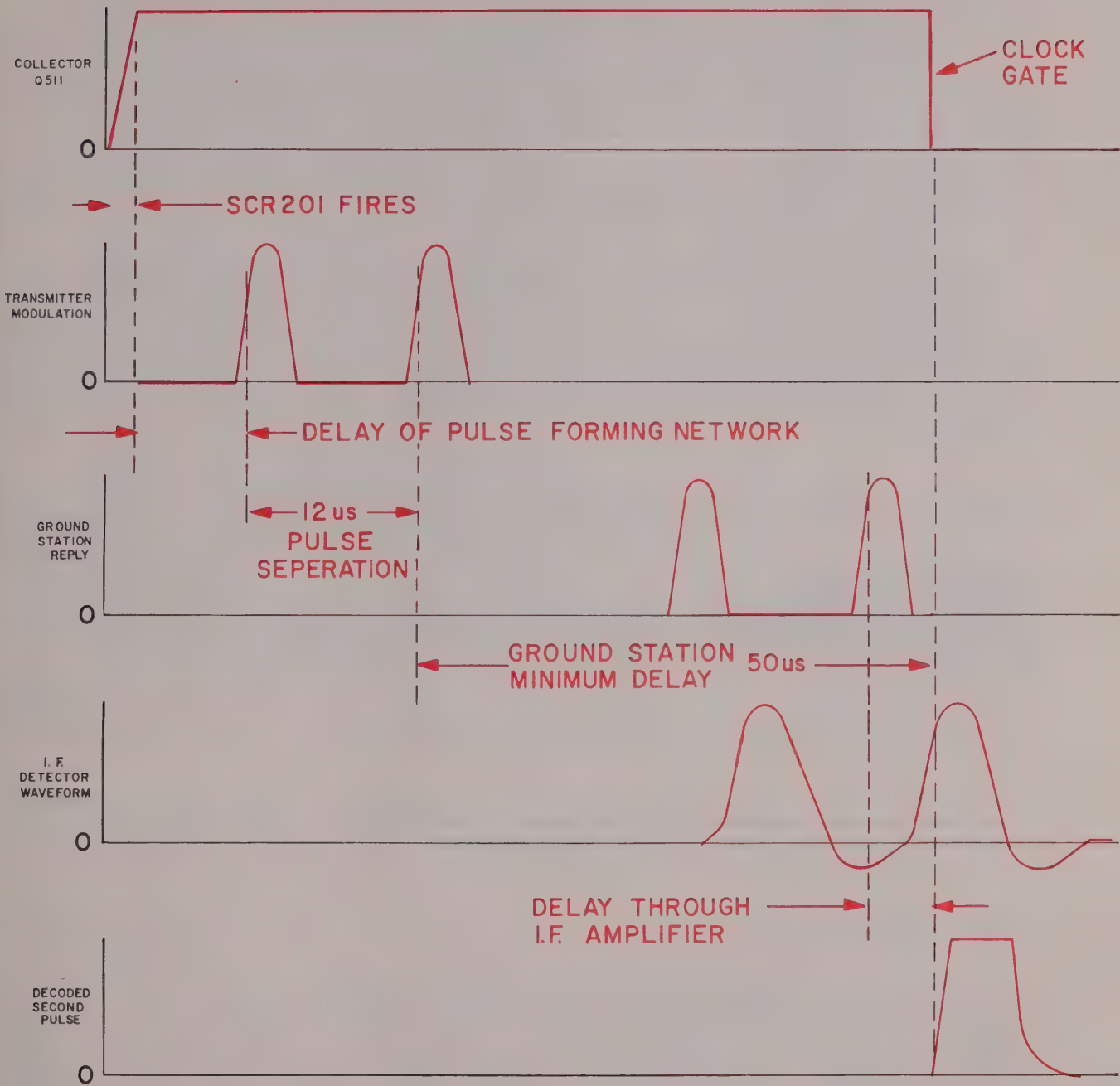


Figure 3-33. Zero Mile System Delays

pulse and will be set if a return is recognized by the gate board during the interrogation cycle. A return is any one of the three error conditions mentioned in the Gate Board Section.

With no returns, Q-516 will be on and Q-516 off, and the collector voltage at Q-517 will be essentially zero. As replies are received, Q-517 will be in the off condition part of the time. If a return is recognized for every interrogation, Q-517 will be off nearly all the time and the voltage at that point will be high. The dc average voltage at the collector of Q-517 over several interrogation cycles is a function of the ratio of returns to interrogations. The voltage at the collector of Q-516 will be the inverse of that at Q-517; that is, this voltage will be high when the return ratio is low. See Figures 3-34 and 3-35.

SEARCH-TRACK DECISION. An integrating circuit is connected to each side of the returns ratio binary. These two circuits (Q-518, Q-515) control the mode (search or track) of the system by monitoring the return ratio over a number of interrogation cycles.

Assume the unit to be in search. The search-track binary (Q-519, Q-520) will be in the search state with Q-519 off. The marker will be advancing in time and distance as each new trial distance is discarded. With no returns, Q-517 will be on and C-525 will be discharged through R-566 and R-567. As the marker advances to within 15 microseconds of the reply, the error detectors in the gate board will trigger, and in turn trigger the returns ratio binary. If the return ratio is large enough (30% or greater) C-525 will charge through CR-518 and R-567 to the firing potential of Q-518. Q-518 on firing, will trigger the search-track binary with a positive pulse through R-573. The unit will then be in the track mode and will continue in this mode as long as returns are sensed. Q-518 will continue to fire in a sawtooth fashion but cannot further affect operation.

The presence of a high return ratio implies that the collector voltage of Q-516 will have a low dc average value. This will keep C-524 discharged due to the path through CR-516 and R-558 in series with Q-516. Should returns be lost, however, Q-516 will generate a high dc average voltage and discharge of C-524 will no longer occur. C-524 will slowly charge due to current through R-555 towards the firing voltage of Q-515. The time from loss of returns to firing varies from about 9 to 15 seconds depending somewhat on whether the return ratio was high or low before it went to zero. If returns are regained before Q-515 has fired, C-524 will be rapidly discharged through R-558. When Q-515 fires, it triggers the zero reset binary, beginning a sequence which places the unit in search mode.

ZERO RESET BINARY. The Zero Reset Binary (Q-513, Q-514) is emitter triggered and reverses state whenever Q-515 fires. The normal resting condition is with Q-513 off. CR-511 will be reverse biased and CR-512 forward biased. The memory reset line from the motor control (Pin M, J-405) will be at +28 volts unless a motor is running, in which case it will be grounded.

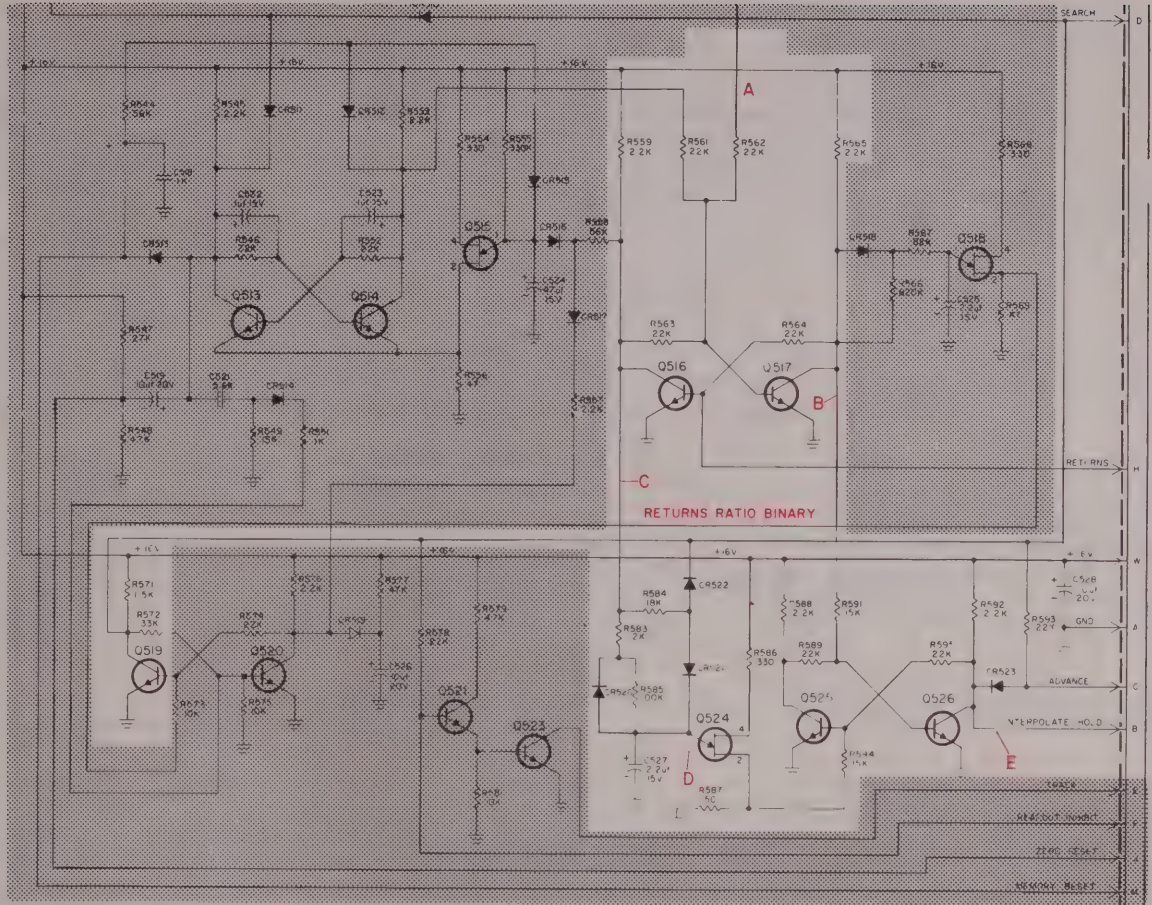
C-519 will be charged to about +12 volts so that when Q-513 turns on, a negative pulse is applied to the zero reset line which resets all memory registers to a zero indication. When Q-513 turns off again, the positive going wave form at that collector is coupled through C-521, CR-514 and R-551 to the base of Q-520, switching the search-track binary to search mode.

The zero reset binary can be triggered in two ways; by Q-515 due to loss of returns while in track mode, or by a channeling operation at anytime.

If triggered by a channeling operation, the memory reset line goes to ground potential, pulling the collector of Q-513 to ground through CR-513. A zero reset pulse from C-519 resets the memory registers. With Q-513 at ground potential, Q-514 turns off and latches Q-513 on. CR-511 becomes forward biased, inhibiting the prf generator Q-502 through CR-502 and R-506. The unit resets in this condition until the motors stop running. When the tuning motors come to rest at the selected channel, the memory reset line returns to +28 volts, causing current to flow through R-544. This current flows through CR-515, charging C-524 to the firing potential of Q-515. Q-515 fires, turning Q-513 off and Q-514 on. As Q-513 turns off, the search-track binary is triggered into search mode. CR-511 becomes reverse biased and the unit begins to search out from zero miles at the high prf rate. With Q-514 on, the current through R-544 is shunted to ground through CR-512 and no flow exists through CR-515.

If the zero reset binary is triggered by Q-515, the same sequence as above is followed. However, the memory reset line will be at +28 volts and Q-515 will retrigger in about one-half of a second due to current through R-544 and CR-515. The purpose of the half-second delay is to allow the readouts time to roll around to the zero indication before their drive is removed. Thus, the search-track binary waits this time interval before being driven into the search state. Reference to Figure 3-35 illustrates some of these sequences.

LAST RETURN FUNCTION. Unijunction Q-524, and a binary element (Q-525, Q-526), form a circuit called the Last Return Delay Generator. This circuit operates when four consecutive returns are missed. Any return will reset the circuit so that the delay begins again from the last received return. This cir-



LAST RETURN DELAY GENERATOR

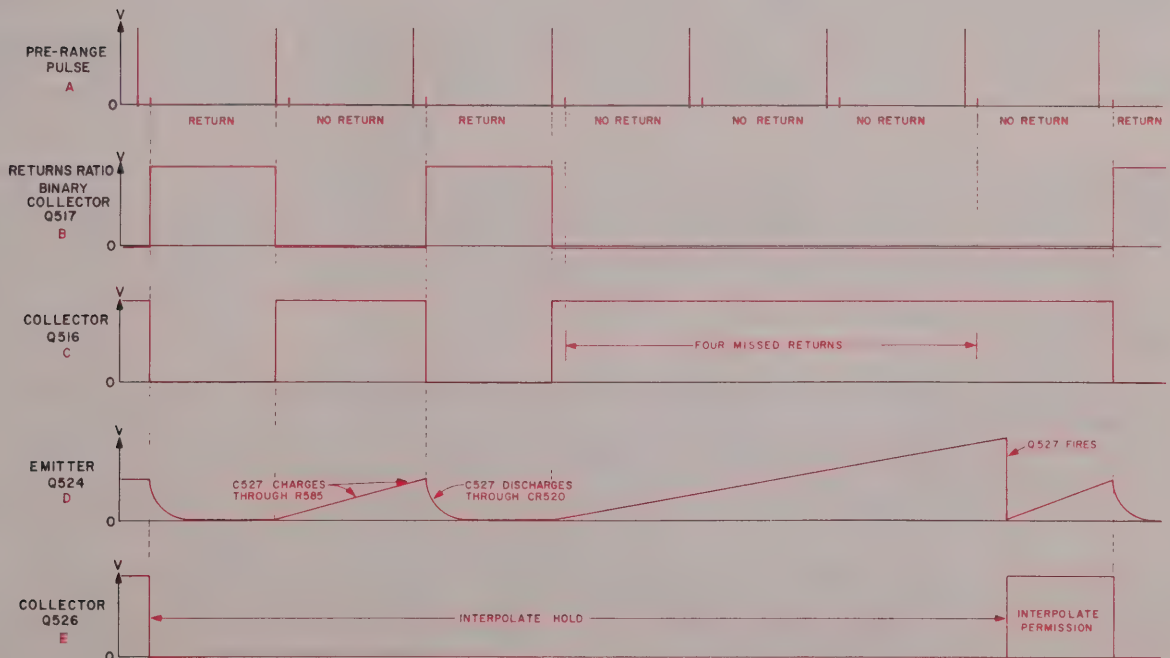
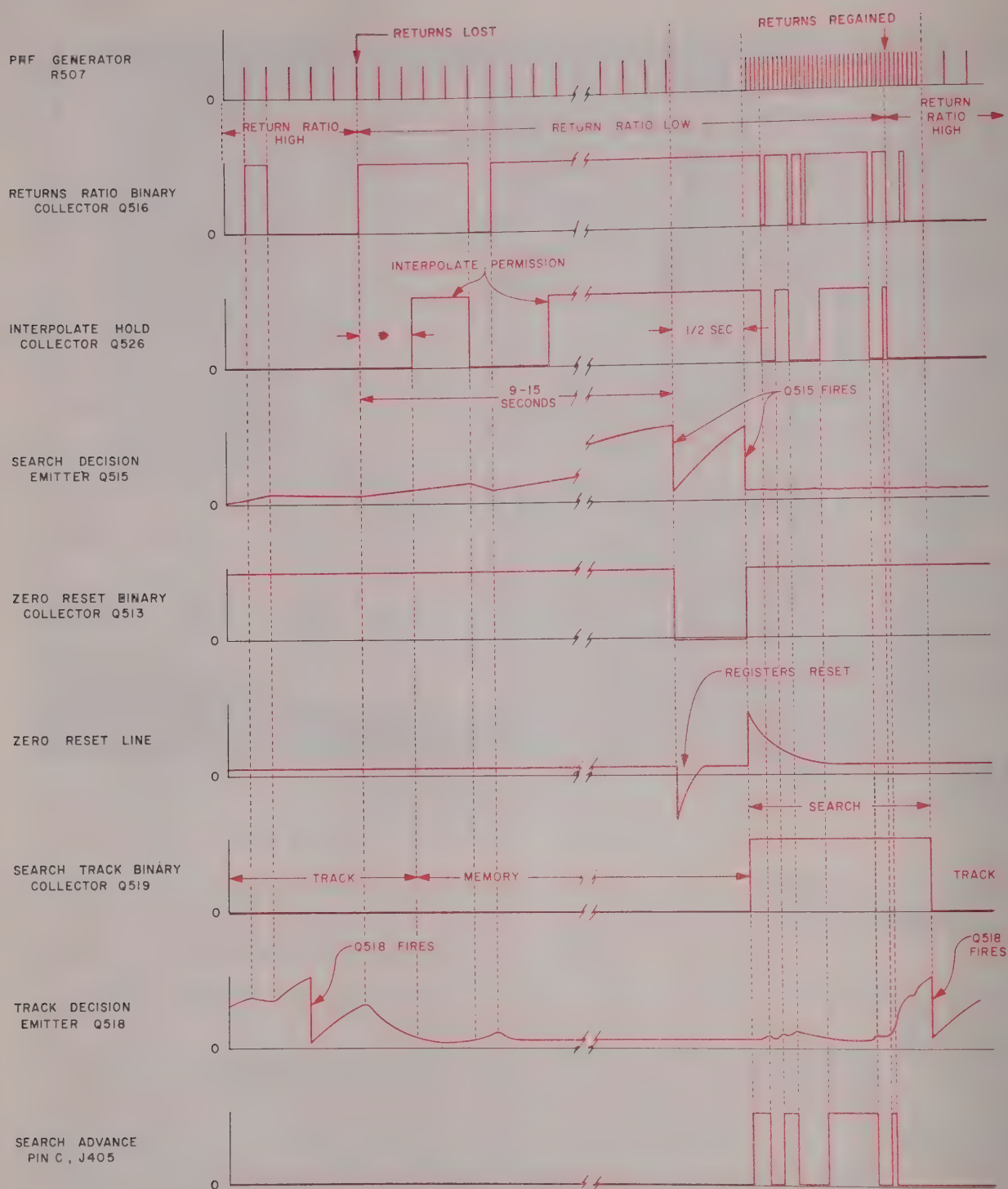


Figure 3-34. Last Return Circuitry and Wave Forms



NOTE: TIME NOT TO SCALE.

* NOTE THERE ARE FOUR CONSECUTIVE MISSED REPLYS.

THE ABOVE ILLUSTRATES IN THE FOLLOWING ORDER: TRACK, LOSS OF RETURNS, MEMORY, ZERO RESET, SEARCH, SEARCH ACQUISITION, AND RESUMPTION OF TRACK.

Figure 3-35. Initiation Board Wave Forms

cuit controls interpolation during track mode and search advance during search mode.

The general operation of the circuit is as follows: During search, the marker is advanced by 0.2 nm each interrogation, while seeking a reply zone. If a return is detected, it is necessary to hold the last distance for several interrogations to determine if this is a random occurrence or a valid reply zone. If no further returns are detected for four consecutive interrogations, marker advance can resume. However, if another return is received, for instance on the third interrogation, the delay will be reset and start again from the last return, delaying marker advance by at least four additional interrogations. In track mode, the operation is similar in that the circuit allows interpolation after sensing several consecutive missed replies.

Reference to Figure 3-34 will clarify the following discussion.

Assume first that the system is in track mode. This implies that the search-track binary is in the track state with Q-519 on. The search line will thus be at ground potential, shunting any current through R-584 from Q-516 to ground. CR-521 will be reverse biased and will not affect operation.

When a return is received, Q-516 will be turned on and Q-517 turned off for the remainder of that interrogation cycle. This will turn on Q-526 through R-591 (Q-526 may already be on, in which case this condition will produce no effect). C-527 will discharge rapidly through CR-520 and R-583 into the "on" Q-516. The pre-range pulse at the start of the next interrogation will reset the returns ratio binary, which will remain reset, if no return is received. C-527 will be slowly charged through R-585 and R-583 from the high collector voltage of Q-516. If no return is received before C-527 charges to the trigger voltage of Q-524, the unijunction will fire, turning on Q-525. Q-526 will release the interpolate hold line from ground potential and allow interpolation to take place at the gate board.

If a return is received before Q-524 has fired, C-527 will be rapidly discharged and the delay must start again from the next missed return.

In search mode, CR-522 is reverse biased, allowing R-584, through CR-521, to parallel R-585 in charging C-527. This allows for the increase repetition rate in search and lowers the charging time of C-527 so that it again corresponds to about four interrogation cycles. R-593 will conduct current from the positive search line to the advance line. This allows search advance unless Q-526 is on from a previous return, in which case the advance line is grounded through CR-523, halting search advance.

3.4.9 IDENTITY CIRCUIT.

The Identity Circuit begins with a takeoff point on the video pulse stretcher, Q-619 and Q-620, on the gate board. The pulse stretcher is simply a monostable which is triggered on for about 150 microseconds by each pulse from the I-F section. The collector of Q-619 goes positive during this length of time and applies a voltage block to the filter network of R-705, R-706, R-707, and C-623. The purpose of the network is to change the ratio of the dc component to the ac component of the voltage block. The output of the network is applied directly to the base of Q-811 on the operation board. Note that this network is the only source of dc bias for this stage.

Q-811 and Q-812 form a darlington circuit with a voltage gain of about 40, with the output reversed in phase with respect to the input. The negative feedback network from collector to base of Q-811 which includes R-851, R-852, R-853, C-822, C-823, and C-824, is a "Twin T" network which has a notch in its transfer characteristics at 1350 cps. This means that at 1350 cps the amplifier has its full gain of 40. At other frequencies a large part of the output is fed back to the amplifier input through the "Twin T" network in such a fashion as to cancel the input voltage, thus reducing the net gain of the amplifier to near unity.

In addition to the band-pass characteristics of the network-amplifier combination, a band-pass is obtained by use of the net dc component out of the pulse stretcher. If the pulse stretcher is being triggered at a low rate, then its output voltage will average slightly above ground. At a high trigger rate, say 2700 prf, the output voltage will average about 10 volts. This dc voltage is chosen so that at 1350 prf, it will bias Q-811 and Q-812 at the middle of their operating point. At lower or higher prf's these transistors will be biased toward cut-off or saturation, respectively.

The sine-wave 1350 cps from the amplifier is applied to the base of Q-813. Q-813 is an audio phase inverter which supplies two signals 180° apart to the bases of the push-pull output transistors, Q-814 and Q-815. Q-814 and Q-815 operate in class B to provide 50 to 100 milliwatts of sine-wave identity tone. R-859 acts as dc bias for Q-813 and supplies negative feedback for the audio circuit.

3.5 MOTOR CONTROL.

The megacycle and kilocycle tuning motors, M-101 and M-102, are actuated by the motor control located on the back panel of the video cage. The motors operate on +28 volts dc from the power supply inverter rather than directly from the A+ input line.

Frequency selection is made by grounding two out of five control wires according to the standard ARINC two out of five coding.

With two wires grounded, the motor associated with that set of five will be caused to run until it finds a wafer switch position that breaks connection between those two wires and the motor control. Only one wafer position exists that meets this requirement for a given selected frequency.

3.5.1 MOTOR SWITCHING.

If, for example, a new kilocycle selection was made, a ground condition would exist at the junction of CR-1102, CR-1104 and R-1103 due to a path through the wafer switches. This ground condition turns on Q-1102, the kc motor switch, through CR-1104. Q-1102 conducts, essentially grounding the negative terminal of M-102 through CR-1108. Q-1104 is off during this time as its base is grounded. M-102 will run, turning the tuning shaft on the R-F unit through a Geneva gear reduction until the motor control wafers are in such a position that both grounded wires are disconnected from the input line. When this happens the input line returns to +28 volts due to current through R-1103. Emitter follower Q-1104 turns off Q-1102 and brakes the motor by allowing current to flow through CR-1106 and R-1106.

3.5.2 MOTOR DAMPING.

Due to the nature of the Geneva drive mechanism, the motor engages the output shaft periodically and turns freely between engagements. This allows the motor to build up speed before assuming the shaft load. After turning the output shaft to a selected position, the motor must stop before it re-engages the transfer mechanism. The braking action is provided by the motor damping transistor, Q-1104 (in the case of the kc motor, M-102) and the damping rate determined by the 33 ohm resistor, M-1106.

As the tuning shaft reaches the selected position, motor switch Q-1102 is turned off, as mentioned. The spinning motor then becomes a generator, inducing a voltage at its terminals of the same polarity as was originally applied. Q-1104 and CR-1106 permit R-1106 to load this generated voltage rapidly, halting the motor.

3.6 POWER SUPPLY SECTION.

The power supply section provides eight separate output voltages, two of which are regulated and six of which are unregulated. The regulated output voltages are +16 and +20 volts dc. The unregulated output voltages are +6.0, +27.5, -27.5, -150 volts dc, and two 200 volt half-wave unfiltered outputs.

The power supply section also provides three other functions. First, a voltage selector switch changes taps on the converter transformer primary winding and arranges the filament circuitry so that operation from either a 14 or 28 volt input power bus is possible. Second, an input filter, between the primary power bus and the converter, both isolates line noise and provides transient protection for the converter. Finally, it provides the closely regulated voltages that are required for stable operation of critical circuits.

3.6.1 DC CONVERTER.

In converting the dc line voltage to the various dc voltages mentioned above, a single transformer-common collector type dc to dc converter is used. The common collector configuration allows the switching transistors to be mounted on the outside of the rear plate which aids in heat dissipation. Since the cases of the exposed transistors are at ground potential, shock hazards to maintenance personnel are reduced.

In order to more fully understand the operation of the converter, consider the power supply schematic (Section VII). Note that the basic inverter consists of the switching transistors Q-1201 and Q-1202 along with the transformer T-1201. The transformer is a conventional inverter type, being wound on a core which is characterized by a square loop hysteresis curve.

Looking at the power supply schematic (Section VII), assume that power has just been applied to the converter. The input voltage is felt at points 20, 21, 22, and 25, 26, 27 (assuming that the magnetizing current is still quite low). The voltage dividing networks R-1202, R-1204 and R-1207, R-1205 provide a bias of approximately 0.3 volt on each switching transistor, which tends to bias them on. However, due

to variations in the transformer, the resistive dividing networks, and especially the current gain on the transistors, one transistor is favored over the other for a biased on condition. For illustration, assume Q-1201 is the favored transistor and that it is driven toward saturation. As the collector current increases, the magnetizing current also increases.

Once Q-1201 saturates, the voltage across the first half of the primary winding of T-1201 is equal to the input voltage less the saturation voltage of Q-1201. The transformer windings are phased in such a way that the feedback windings provide an "ON" bias for Q-1201 as well as an "OFF" bias for the opposite transistor Q-1202.

With a continued current in one direction of the transformer primary winding, the core will eventually reach a point at which its permeability begins to rapidly decrease. This core saturation reduces the inductive coupling between windings, at which time the transistors begin to lose the base drive obtained from the feedback winding. With a reduced feedback voltage, the "ON" transistor is pulled out of saturation and the "OFF" transistor is biased toward the "ON" condition, starting the second half of the cycle.

To simplify the above discussion, only the conventional voltage dividing network was used to show starting conditions. Since the receiver/transmitter provides extensive filtering on the inverter output, and since the secondary windings are all magnetically coupled to the input, the switching transistors must supply a very heavy surge of collector current during the initial starting period. With a resistive voltage divider starting circuit alone, the base drive would be limited by the resistors used in that network. This limited base drive would result in poor starting under worst case conditions.

By the addition of the high voltage base return network (see Section VII), any current flowing into the high voltage filter capacitor C-1209 and the +150 volt line must pass through the base of one of the switching transistors. Therefore, when power is first applied, the base drive of the favored transistor is increased by an amount equal to the charging current of C-1209. This increased base drive enables the switching transistors to conduct the large collector current required when the secondary voltage filter capacitors are in a discharge condition.

Once the inverter has started, the base drive of the switching transistors is reduced to normal (plus the small load required by the +150 and +200 volt output).

The resistor-diode networks (R-1203, CR-1201 and R-1206, CR-1202) are included to reduce the base drive requirements during normal operation. They offer a low impedance path when forward biased.

The capacitors C-1205, C-1206, C-1207, and C-1208, along with R-1202 and R-1207 form speed up networks which improve switching time.

Due to the transformer action between the primary windings, a voltage is induced in the "off" winding with its phase such that it is additive with the input voltage. Therefore, a voltage of approximately twice line voltage will appear across each transistor (emitter to collector) during its "off" period. The inverter wave shapes are shown in Section VII. The converter is designed around a 2 kc center frequency.

3.6.2 INPUT VOLTAGE SELECTION.

The receiver/transmitter will operate from either a +13.75 or a +27.5 volt bus, as selected by switch S-1206. By doubling the primary turns of T-1201 for a +27.5 volt input, the turns per volt ratio is kept constant. Since both the inverter frequency and output voltages are functions of the turns per volt ratio, they will remain constant.

3.6.3 INPUT FILTER.

The "low pass" input filter (C-1204, L-1201, C-1201, L-1202, C-1202 along with C-1203), also performs three functions:

1. First, it filters any noise or stray interference that may exist on the power bus, and prevents it from entering the unit.
2. It filters out any noise or stray interference that is generated within the unit itself, and prevents it from being fed into the main power bus.
3. It functions as a transient suppressor, reducing the possibility of a failure caused by high voltage transients occurring on the main power bus.

3.6.4 REGULATOR.

The power supply section provides two regulated outputs, +16 volts dc and +20 volts dc. A conventional

series regulator is used to obtain the +16 volts dc output, and a 3.9 volts zener is used in a "boot strap" arrangement to obtain the 20 volts dc output. Theory of operation can best be followed by referring to the power supply section schematic in Section VII.

The zener diode CR-1218, in conjunction with the biasing resistor R-1218 and filter capacitor C-1216, provide the reference element. The resistor R-1218 insures that the zener is biased in the stable region of its characteristic curve.

The ratio of resistor R-1215, R-1216, and R-1217 control the regulator output voltage. R-1216 is selected for an exact +16VDC output.

On later units, R-1216 is an adjustable multiturn potentiometer connected as a rheostat. It is accessible from the top of the unit and is located directly behind the rows of test points.

Q-1205 functions as a comparison element (reference amplifier) by comparing the sampled output with that of the reference.

If an error exists, the dc amplifier Q-1204, in conjunction with the control element Q-1203, will adjust the output voltage level until the error returns to zero, thus maintaining the regulated +16 volts output.

The +20 volts regulated supply is obtained by boot strapping a +3.9 volts zener (CR-1217) between the +16.0 volts regulated supply and the nonregulated 28 volts dc inverter output through the current limiting resistor R-1212.

3.7 INDICATOR.

The DME Indicator contains distance readouts and a knots (KTS) and time-to-station (TTS) indicator. Solid-state circuitry on five circuit boards, servo boards #1 through #5, is included in the indicator. It develops signals from the remote receiver/transmitter unit to display information on the servo-operated KTS-TTS indicator. The servo boards are numbered from front to rear with servo board #1 nearest the front panel.

The four distance readouts across the upper window are actuated by the remote receiver/transmitter to display distance to the nearest tenth mile. The left hand readout displays a warning flag when the unit is turned off and also when the system is not presenting valid information, as during search mode.

A three-position switch, S-601, in the lower left corner of the indicator panel, selects either of the two omni receiver's frequency controls to channel the DME. With this switch in the middle position, the DME remains tuned to the last selected DME ground station. This feature allows both omni receivers to be tuned to frequencies not related to the desired DME ground station.

The KTS-TTS switch, S-602, in the lower right corner of the indicator, controls the function of the servo-driven counters in the lower window. With S-602 in the KTS position, relative velocities of zero to 599 knots may be displayed. With S-602 switched to TTS, time to station in minutes is displayed. This information is derived from both distance and relative velocity. The maximum time displayed is 59 minutes.

Instrument lighting is provided by six 5 volt bulbs in the front panel. The bulbs are connected in series for 28 volt operation and series-parallel for 14 volts by a jumper terminal board at the lower rear of the indicator.

3.8 SERVO BOARD #1.

Servo Board #1 includes two amplifiers that produce ac output voltages of proper phase and amplitude to operate a two phase ac motor, M-601. Two negative dc voltage signal inputs are required by one of the amplifiers. The first of the two inputs is derived from the wiper arm of a ten turn precision potentiometer, R-601, rotated through its range by M-601 through reduction gearing. Since the servo amplifier is a null-seeking system, a negative voltage applied to the second signal input terminal will cause an output voltage to be applied to the variable phase winding of M-601. R-601 will then be rotated by M-601 in the proper direction so that the voltage on its wiper arm approaches the voltage at the second signal input terminal. When the two input voltages are equal, the variable phase voltage developed by the servo amplifier reduces to zero and M-601 stops. M-601 is also geared to turn counter dials in the lower window of the indicator that will present any number between zero and 600. Thus, the number presented by the counter dials is directly related to the position of R-601's wiper arm, which in turn depends on the voltage applied to the second input terminal. This system may be thought of as a digital voltmeter, with a reference voltage applied to the ungrounded end of R-601 and a voltage to be measured applied to the second signal input terminal.

3.8.1 UNIJUNCTION OSCILLATOR.

Ac voltage wave forms required by the servo amplifier are initiated by Q-104, a unijunction oscillator, whose nominal frequency is 400 cycles. At initial turn-on, the anode of CR-102 will be about 1.4 volts positive with respect to ground, due to voltage drops in CR-102 and the base emitter junction of Q-107. As C-106 charged toward +16 volts, current through Q-107's base increases, driving it hard into saturation. When C-106 charges to a critical voltage, about +10 volts, the resistance between the emitter and the grounded base of Q-104 suddenly drops from a very high to a very low value. The positively charged end of C-106 is thereby brought to ground, so that its negatively charged end now back-biases CR-102 and base drive is removed from Q-107.

3.8.2 FIXED PHASE DRIVE.

One end of the fixed phase winding of M-601 is connected to the +16 volt supply bus, the other end connects to Q-106's emitter and Q-107's collector through C-109. Q-106 and Q-107 comprise a "boot strap" amplifier. When Q-107's base is driven positive, its collector to emitter resistance drops to a very low value. Since the emitter of Q-107 is grounded, the emitter base of Q-106 also approach ground potential at this time. Q-106 is an emitter follower, with its emitter to ground voltage following changes in base to ground voltage. With base drive removed from Q-107, its collector to emitter voltage becomes high and Q-106's emitter follows, with its voltage also approaching +16 volts. Therefore, when C-106 in the unijunction oscillator circuit is charging, the end of the fixed phase winding connected to C-109 approaches ground with nearly +16 volts across the winding. When C-106 is discharging, the negative side of C-109 approaches +16 volts with close to zero volts across the fixed phase winding. These effects produce a nearly rectangular wave form across the fixed phase winding of M-601 with a peak to peak voltage of almost +16 volts and a frequency of approximately 400 cycles per second.

3.8.3 VARIABLE PHASE DRIVE.

The speed and direction of M-601's rotation depends on the amplitude and phase of voltage applied to the variable phase winding. Maximum torque is developed by M-601 for a given variable phase voltage when the phase difference between fixed and variable phase windings is exactly 90 degrees.

Q-103, Q-105 and Q-108 comprise the variable phase drive amplifier. Q-101 and Q-102 are chopper transistors. A 400 cycle wave form from Q-104 is applied between the bases and collectors of Q-101 and Q-102 through T-101. When the base of either of these choppers is made positive with respect to its collector, a negative voltage present on its emitter will also be present at the collector. When the voltages on the emitters of Q-101 and Q-102 are other than equal, the resultant wave form at the input to Q-103 is a square wave with a voltage equal to the difference of the two emitter inputs and of the same frequency as that produced by Q-104.

Q-103 is a phase shifting amplifier. A feedback network between the collector and base of Q-103 consisting of C-104, C-105 and R-107 produces a 90 degree phase shift between input and output wave forms of Q-103. This network is frequency conscious so phase shift will be 90 degrees only if the unijunction 400 cycle oscillator is on the proper frequency. Q-103's input wave form is a square wave and its output wave form is a sine-wave. Q-105 and Q-108 amplify the sine-wave output of Q-103 and apply it to the variable phase winding of M-601 with little further phase shift. While the fixed phase winding of M-601 is dc blocked by C-109, the collector current of Q-108 flows through the variable phase winding. This dc component in the variable phase winding causes damping to prevent excessive high speeds that could cause damage at either rotation limit of R-601.

3.8.4 SERVO OPERATION.

When the voltage at the emitter of chopper transistor Q-101 is higher than the voltage at Q-102's emitter from the wiper arm of R-601, the phase of M-601's variable phase winding will be such that M-601 will rotate in the direction that causes R-601's wiper arm to present an increasing voltage to Q-102's emitter. As the voltage at R-601's wiper arm approaches the voltage at Q-101's emitter, the chopper output to Q-103 will become less, resulting in less variable phase excitation and slower speed of M-601. When R-601's wiper arm voltage presented to Q-102's emitter finally equals Q-101's emitter voltage, the collector voltages of each will be equal to the time these choppers are alternately driven into conduction by T-101's secondary wave form. This condition results in a loss of square wave input to Q-103, therefore, no variable phase drive and M-601 stops.

If Q-101's emitter voltage now becomes less than the voltage at R-601's wiper arm, the variable phase drive voltage will change by 180 degrees from the other case. A 90 degree phase difference, now of the opposite sense, is maintained with respect to the fixed phase wave form. This will cause M-601 to change R-601's setting until a null condition is again reached, now at a lower point on R-601. Since the counters in the lower window are geared to M-601 and R-601, they will now read a lower number than

previously.

3.8.5 VELOCITY REFERENCE ADJUSTMENT.

When the KTS-TTS switch is set to KTS to present velocity information, the reference voltage switched to the ungrounded end of R-601 is adjusted to -6.0 volts with the velocity reference adjustment, R-101. This must be done only with a voltmeter with known high accuracy. Note that the negative voltage at terminal 1 of R-101 is double regulated, first by zener diode CR-302 on servo board #3 and then by zener diode CR-101 on servo board #1.

3.8.6 SERVO OPERATION CHECK.

A rough check on servo board #1 operation can be made by removing the input wire to the emitter of Q-101 and connecting a variable voltage source, such as a +6 volt battery with a 10 k ohm pot across it. Connect the positive battery terminal to ground and the pot wiper arm to Q-101's emitter. The counter dials should read the voltage as measured from Q-101's emitter to ground with a voltmeter. For this check, the KTS-TTS switch must be in the KTS position.

3.9 SERVO BOARD #2.

Ranging circuitry in the receiver/transmitter is digital, but the velocity readout is an analog system. The conversion of digital velocity information to an analog form is accomplished by servo board #2.

Each change in the tenth mile readout provides an input to servo board #2 from either the add or subtract flip-flop on the gate board, depending on whether the aircraft is inbound or outbound from the DME ground station. Every pulse from the gate board causes servo board #2 to generate a voltage block, precisely controlled in both amplitude and time of duration. These precision pulses are integrated by a long time constant network to produce a dc voltage whose amplitude is directly related to the relatively velocity between the aircraft and the DME ground station. This voltage, amplified by servo board #3 and presented to servo board #1, determines the number read out on the KTS counters. It is also used as one of two variable inputs to servo board #1 when time to station, (TTS), information is displayed.

3.9.1 PRECISION BLOCK GENERATOR.

Three interrelated circuit functions produce a voltage block for each tenth mile of indicated change in distance. These circuits are a pulse width generator (Q-202 and Q-203), voltage regulator (Q-204 and Q-205), and a velocity flip-flop (Q-206 and Q-207).

Q-206 and Q-207 form the velocity flip-flop with Q-206 normally conducting and Q-207 normally cut-off. A positive pulse from the gate board applied to the base of Q-207 drives it into conduction, which in turn removes base drive through R-216 to Q-206, causing its collector voltage rise. Q-207's base now receives drive through R-215, maintaining Q-207's state of conduction.

Q-204 is an emitter follower used as a series voltage regulator to precisely control the voltage applied to Q-202. With Q-206 in its previous state of conduction, Q-204's base was grounded and no voltage was available to Q-202 from Q-204's emitter circuit. Now, with Q-206 nonconducting, base current is available to Q-204 through R-213, allowing conduction through Q-204.

Q-205 is a special reference amplifier that controls the voltage available at Q-204's emitter by controlling Q-204's base current. Q-205 has a zener diode built into its case, providing a voltage reference for Q-205's emitter. This device is specially constructed to provide a very stable control of Q-204's emitter voltage over a wide temperature range. R-211 and R-212, in the base circuit of Q-205, are special resistors whose temperature coefficient is well matched over wide temperature variations. Any tendency for Q-204's emitter voltage to rise results in increased base drive to Q-205. Q-205 therefore, draws more collector current through R-213, resulting in a lowered voltage at Q-204's base and return of Q-204's emitter voltage to the desired value. Likewise, if Q-204's emitter voltage drops, Q-205's base drive will be less, Q-205 will draw less current through R-213 and more current will flow through Q-204's base to return Q-204's emitter voltage to the desired value. The voltage at Q-204's emitter is about +13 to +14 volts, but the absolute value is not nearly as important as the fact that it is extremely constant over a wide temperature range.

3.9.2 UNIJUNCTION RELAXATION OSCILLATOR.

Q-202 is a unijunction relaxation oscillator whose time constant is determined by C-202, R-208 and the setting of R-209. When Q-206 in the velocity flip-flop is made nonconductive by the positive gate board input to Q-207 and Q-204's emitter voltage is allowed to rise to its regulated value, the regulated voltage begins to charge C-202 through R-208 and R-209. When the voltage applied to Q-202's emitter rises

to about six-tenths of the voltage at Q-204's emitter, the resistance between Q-202's emitter and lower base drops sharply, partially discharging C-202 through R-206. The time required to charge C-202 to this critical point, about 150 milliseconds, may be varied over a narrow range by adjustment of the velocity calibration pot, R-209. Clockwise rotation of R-209 decreases the time interval before Q-202 conducts, while counterclockwise rotation increases the time interval.

A positive voltage spike across R-206 when Q-202 conducts is fed to the base of Q-206 through R-217. Q-206 conducts, with its collector voltage dropping to nearly zero. Base drive to Q-207 through R-215 is removed and Q-207's collector voltage rises, maintaining Q-206 in a conducting state with base drive through R-216. Q-204's base is also brought to ground, resulting in zero voltage at its emitter.

Q-202 does not completely discharge C-202, and it is desirable to have every charging cycle of C-202 take the same length of time. Since Q-207 is nonconducting at this time, Q-203's base is driven through R-220. Q-203, through R-207 in its collector circuit, rapidly completes the discharge of C-202. This insures that every gate board pulse, regardless of its spacing, starts charging C-202 from zero volts.

3.9.3 INTEGRATING OUTPUT CIRCUIT.

The previous paragraphs outline the following sequence of events: When in the track mode, every tenth mile change in the digital ranging readout introduces a starting pulse to servo board #2. This pulse immediately causes a regulated voltage to appear at the emitter of Q-204. A short time later, Q-202 causes the regulated voltage to cease, and these circuits await the next gate board tenth mile initiation pulse.

A long time constant, low pass integrating filter network consisting of R-233, C-203 and R-224 is charged by the regulated voltage of Q-204's emitter during the intervals it is present. The network's time constant is of such a length that many tenth mile crossings are required to arrive at a stable value of charge on C-203. It may be seen that a higher velocity, with more tenth mile crossings in any given period of time, will result in a higher net voltage at the output of the filter network. This output is one of the signal inputs to servo board #3.

3.9.4 AMPLIFIER FEEDBACK NETWORK.

The operational amplifier on servo board #3 receives its input from the integrating output circuit on servo board #2. A feedback network, consisting of R-225, R-226, C-204 and C-205 applies a portion of the operational amplifier's output to its input as negative feedback.

The gain of the operational amplifier on servo board #3 would be quite high, around 5000, if no feedback was applied. With the effective gain reduced to a low value by the large negative feedback, the overall gain is very stable. The ratio of the average dc level from the precision block generator to the output voltage from the operational amplifier on servo board #3 is determined by the resistance values in the feedback network.

While the operational amplifiers output follows changes in the average dc level to the filter network at its input, negative feedback maintains the voltage at the base of Q-301 near zero with respect to ground.

3.9.5 VELOCITY CLAMP.

During the first part of the track mode, input pulses may be applied to servo board #2 from the gate board that are meaningless in terms of velocity. Q-201 functions as a clamp device during about the first 15 seconds of track to hold Q-206 in a conducting state. This insures that the velocity flip-flop is triggered by gate board pulses that are due to actual changes in distance.

During search, CR-202 and CR-203 are back biased by a positive voltage from the search-track binary on the initiation board. Q-201 receives base drive through R-202 and CR-201. With base drive, Q-201 conducts so that no base drive is available to Q-206 through R-204. The anode of CR-201 will be held to about 1.2 volts positive, due to the base-emitter gap of Q-201 and the forward drop in CR-201. C-201 will therefore, charge to about +14 volts through R-201.

When the unit goes into track, the cathode of CR-203 is grounded by the search-track binary. The positively charged end of C-201 is brought near ground and the negatively charged end of C-201 back biases CR-201, removing base drive from Q-201. With base drive removed, Q-201 no longer conducts. Base drive to Q-206 through R-204 and R-218 maintains Q-206 in a state of conduction. Gate board pulses to the base of Q-207 cannot change the state of the velocity flip-flop while this condition exists.

After about 15 seconds, C-201 will be discharged through R-202. The back bias is removed from CR-201 and Q-201 returns to a state of conduction. Excess base drive to Q-206 is removed and the velocity flip-flop may function normally.

CR-202 and CR-203 provide a voltage drop so that C-201, a polarized capacitor, is not charged in the reverse direction during track mode.

3.10 SERVO BOARD #3.

Servo Board #3 includes a velocity integrator, a voltage to frequency converter and an interpolate synchronizer circuit.

3.10.1 VELOCITY INTEGRATOR.

The primary function of the velocity integrator is to sample and integrate the output voltage of the precision block generator, and convert it into a highly stable velocity reference voltage. This voltage is used by servo board #1 for both the velocity and time to station readout. It is also used by the voltage to frequency converter.

The velocity integrator consists of the operational amplifier Q-301 thru Q-304, with the integrating pre-filter network R-223, C-203, and R-224, and the feedback network R-225, C-204, R-226, and C-205. (It should be noted here that, although these two networks are an integral part of the velocity integrator, they are physically located on servo board #2 and their operation is outlined in that section.)

The operational amplifier can be subdivided into a differential amplifier Q-301 and Q-302, and a dc amplifier Q-303 and Q-304.

The differential amplifier Q-301 and Q-302 is used to compare the sampled velocity input with that of a reference voltage. An error voltage is obtained when an unbalanced condition exists.

Under normal (balanced) conditions, Q-302's base is referenced to ground potential through the base return resistor R-307. The clamping diode CR-303 clamps the collector of Q-302 to the diode gap voltage (CR-303) above ground (approximately +0.6 volts).

Q-301 receives the prefiltered velocity information from the precision block generator located on servo board #2. The average amplitude of this voltage is proportional to velocity. Error voltage is obtained from the collector of Q-301, becoming less positive as the error increases. The clamping diode CR-301 clamps the base of Q-301 to the diode gap voltage above ground, eliminating the possibility of amplifier latch up.

The dc amplifier Q-303 and Q-304 provides additional gain as well as a voltage reference shift.

Any error voltage, that is the direct result of a velocity change, is developed on the collector of Q-301, and is resistively coupled to the dc amplifier input Q-303. If the error is due to an increased velocity, the base drive of Q-303 drops and its collector goes more positive. If the error is due to a decreased velocity, the base drive of Q-303 increases and its collector is driven less positive.

The collector of Q-303 is coupled to the base of Q-304 through the 16 volt zener CR-304. This allows the base drive of Q-304 to follow directly the changes occurring on the collector of Q-303 with the addition of a 16 volt less positive reference level provided by the zener. Therefore, the collector voltage of Q-304 will decrease with an increase in velocity and increase with a corresponding decrease in velocity.

The differential and dc amplifiers described above comprise an operational amplifier. The feedback network, also described above, stabilizes the input voltage (at the base of Q-310) to zero volts under balanced conditions. Any change in the velocity voltage results in a corresponding change in the collector voltage of Q-304. Thus, the collector voltage of Q-304 is the velocity output. Both the operational amplifier's feedback and the velocity output voltage used by servo board #1 are taken from this point. It is also used as a velocity reference for the voltage to frequency network described below.

The velocity zero pot, R-303 is used to eliminate any offset voltages introduced by circuit parameters. It is adjusted to obtain a zero voltage output at the Q-304 collector output reference when the input velocity is equal to zero knots. Once adjusted, the output voltage will vary from 0 to -6.0 volts, being directly proportional to any input velocity from 0 to 600 knots.

3.10-2 VOLTAGE TO FREQUENCY CONVERTER.

The primary function of the voltage-to-frequency converter is to provide an output pulse whose repetition rate is a direct function of the indicated velocity. These output pulses, which are continuously being generated, are fed to the gate board in the video section. They are used to provide an uninterrupted tracking operation of the DME during a temporary loss of ground station returns.

The voltage-to-frequency converter consists of the dc level shift Q-305, the constant current generator Q-307, and the unijunction relaxation oscillator Q-307.

The dc level shift network consists of transistor Q-305 which is made to operate in a common base mode by the base clamping diode CR-305. The common-base alpha of the transistor approaches unity; therefore, the collector current is nearly identical to the emitter current. Since the emitter of Q-305 ties to the velocity reference point on the collector of Q-304 through the emitter resistor R-312, the emitter current becomes a function of velocity. Also, since the collector current is a direct function of the emitter current, the voltage drop across the collector resistor R-313 becomes a function of velocity. Thus, the voltage at the collector becomes less positive as the velocity increases, and more positive as the velocity decreases.

If the velocity goes to zero, Q-305 approaches cut-off since the base bias (obtained from the gap voltage of CR-305) is not sufficient to overcome the base to emitter gap voltage of Q-305, with the emitter tied to the zero reference voltage of Q-304. Thus, under zero velocity, the collector of Q-305 approaches line voltage (+16 volts). In summation, the collector voltage of Q-305 varies inversely with velocity, approaching line voltage when the velocity approaches zero.

The base of the constant current generator, Q-306, is directly coupled to the collector of Q-305. The bias felt on the base of Q-306 is therefore, a function of velocity. As the velocity increases, the base drive on Q-306 becomes less positive, biasing the transistor to a higher conduction level. If the velocity decreases, the base drive on Q-306 goes more positive, reducing the transistor conduction level. If the velocity drops to zero, the conduction level of Q-306 also approaches zero. Therefore, the conduction level of Q-306 is a direct function of velocity, increasing as the velocity increases. This conduction level, a function of velocity, is used to control the charging rate of C-304, which in turn controls the frequency of the unijunction oscillator as will be shown below.

The unijunction relaxation oscillator generates the interpolate pulse, as outlined under the "Voltage to Frequency Converter" section above. To more fully understand the oscillator, consider first the basic unijunction characteristics.

With a positive interbase voltage applied to the unijunction through the resistive network R-317 and R-318, the emitter to base one diode will be reverse biased. It remains in that state until the voltage at the emitter becomes more positive than this voltage, at which time C-304 discharges through R-318. The emitter to base one diode again becomes reverse biased and the cycle repeats itself.

Since C-304 is charged from a constant current source, the voltage developed across it is a ramp function whose slope is determined by the magnitude of the charging current. As shown above, this charging current is a function of velocity. The interpolate calibrate adjust pot, R-316, is used as a fine frequency adjustment by compensating for circuit parameter variations.

The voltage developed across R-318 during the discharge of C-304 is the interpolate pulse which is fed back to the video section.

3.10.3 INTERPOLATE SYNCHRONIZING.

The synchronization of the "Interpolate Out" pulse is accomplished by referencing the start of the C-340 charge cycle with the termination point of the "Gates In" pulse.

When a positively going "Gates In" pulse is coupled to the base of Q-308, the transistor becomes saturated, effectively placing base two of Q-307 at ground potential. This provides a low impedance discharge path for C-304, maintaining it in a fully discharged condition until the "Gates In" pulse is removed. At this point, the next charge cycle will begin.

Since the charge cycle is always synchronized to the last gate pulse, the interpolate pulse (produced at the end of the respective charge cycle) will occur at approximately the same time that the next gate pulse is due if the aircraft is maintaining a constant velocity. This continuity of pulse occurrence between the two pulses will allow the interpolate pulses to be substituted for any missing distance changing pulses (0.1 mile distance changes) in the event of a momentary loss of ground station returns.

Refer to "Interpolation" under paragraph 3.4.7, "The Gate Board" and "Last Return Function" under paragraph 3.4.8 "Initiation Board" for additional discussion on interpolation.

3.11 SERVO BOARD #4

The servo board #4 consists of a matrix that develops an output current which is a direct function of the indicated distance in nautical miles. This matrix output in conjunction with the operational amplifier

located on servo board #5, provides a negative distance voltage to servo board #1 when time to station (TTS) is displayed. When a "1" is indicated by the left-hand readout for distances of 100 miles or more, an additional matrix output on servo board #5 is generated. No matrix outputs are developed for tenth mile readout changes.

For the one and ten mile readouts, voltages applied to the readout coils are also used to control transistors that introduce different amounts of resistance between the +16 volt bus and the sum node bus. All even numbered transistors on servo board #4 have precision resistor networks between the +16 volt bus, their collectors and the sum node bus. The odd numbered transistors, whose bases and emitters are connected to readout coil lines, control base drive to an associated even numbered transistor. If a zero is indicated, all even numbered transistors associated with that readout are in saturation. This places all the resistors between the sum node bus and their collectors in parallel to ground.

Q-420 in the one mile matrix and Q-410 in the ten mile matrix are off for all indicated odd numbers. The following chart indicates transistors that are off for each indicated number of the one and ten mile readouts:

NUMBER INDICATED	1 Mile Matrix	10 Mile Matrix
0	All On	All On
1	Q-420	Q-410
2	Q-418	Q-408
3	Q-418, Q-420	Q-408, Q-410
4	Q-416	Q-406
5	Q-416, Q-420	Q-406, Q-410
6	Q-414	Q-404
7	Q-414, Q-420	Q-404, Q-410
8	Q-412	Q-402
9	Q-412, Q-420	Q-402, Q-410

The values of the precision resistors between the collectors of the transistors in the above chart and the sum node bus are such that a higher indicated distance readout number lowers the resistance between the +16 volt bus and the sum node bus. Since all charted transistors not off for a particular indicated number are in saturation, their precision resistors are in parallel from the sum node bus to ground. Therefore, the total current into the sum node bus from the one and ten mile matrices is determined by the indicated distance. The magnitude of the current from each matrix is proportional to the readout number. An examination of the circuit resistance will show, for example, that the current through R-441 and R-442 when a six is readout is 3 times as large as the current through R-445 and R-446 when a two is readout. Similarly, a "six current" from the mile matrix is ten times greater than a "six current" from the one mile matrix.

3.12 SERVO BOARD #5.

Servo board #5 in conjunction with servo board #4, provides a negative output voltage to the "KTS-TTS" switch servo board #1 only when time to station (TTS) information is to be displayed. This negative output is directly proportional to indicated distance (zero at zero miles and -1.99 volts at 199 miles).

3.12.1 HUNDREDS MATRIX OUTPUT.

A matrix output to the sum node bus is generated by Q-501 and Q-502. This output occurs when a "1" is indicated by the left-hand readout for distance of 100 miles or more. With +6 volts in Pin C, J-604 of the 100 mile readout and R-501, Q-501 conducts heavily. Q-502 loses its source of base drive and changes from a conducting to a nonconducting state. R-505 between the sum node bus and Q-502's collector now connects to the +16 volt bus through R-504. R-505 previously was grounded when Q-502 was conducting.

3.12.2 OPERATIONAL AMPLIFIER.

Q-503, Q-504 and Q-505 comprise an operational amplifier with a large negative output for a small positive input. All three transistor collector resistors are connected to the +16 volt bus and their emitter resistors connect to a -16 volt bus regulated by zener diode CR-302 (on servo board #3). Q-503 and Q-504 form a differential amplifier with the sum node bus providing an input to Q-503's base. Q-504's base connects to the wiper arm of R-511, the TTS Zero Adjust pot. A small positive voltage increase to the base of Q-503 causes its emitter to become more positive. Q-504's emitter, connected to Q-503's emitter, also becomes more positive. This results in decreased conduction through Q-504 with its col-

lector voltage rising. Q-505 is a dc amplifier with a +16 volt zener diode, CR-501, between its base and the collector of Q-504. This diode provides a voltage offset so that Q-505's base is always +16 volts less positive than the collector of Q-504. C-501, across CR-501, prevents any noise generated by CR-501 from being applied to the base of Q-505. This rising voltage at the base of Q-505 causes increased conduction through Q-505, with its collector voltage becoming more negative.

An important feature of this circuit is that the negative output at Q-505's collector is fed back to the base of Q-503 through R-506. This negative feedback lowers the effective input impedance of the operational amplifier to only a few ohms. Thus, the amplifier becomes a current sensing device measuring current flow through those precision matrix resistors that are not grounded. The total resistance of all the other precision matrix resistors, in parallel from the sum node bus to ground, is much higher compared to the low input impedance of the amplifier so that their shunting effect is negligible. This effect may be compared to a low resistance milliammeter shunted by a resistance many times that of the meter movement, which would have negligible effect on the meter current.

At an indicated distance of zero miles, the voltage at the collector of Q-505 should be zero. The "TTS" Zero Adjust pot, R-511, is adjusted to obtain this value. At 199 miles, Q-505's collector voltage should be -1.99 volts. There is no adjustment to calibrate this maximum distance voltage, and its accuracy depends on the precision resistors in the sum node output matrix on servo boards #4 and #5. At other distances the output voltage will be proportional to distance by the factor of -0.01 volts per nautical mile.

3.12.3 OUTPUT FILTER NETWORK.

When the receiver/transmitter is in track mode, the drive to the distance readouts is removed for about 2.5 out of every 37 milliseconds. The distance voltage from the amplifier goes to zero during this time due to loss of drive from the matrices. A filter network, consisting of R-517, C-502 and R-518, removes this notch from the output of Q-505. The result is a jitter-free analog distance input to servo board #1 when TTS information is displayed.

3.12.4 TIME-TO-STATION OPERATION.

It has been shown that the output from servo board #3 is a zero to -6 volt analog function of velocity. It has also been shown that the output from servo board #5 is a zero to -2 volt analog function of distance. The paragraphs following discuss the development of the time to station (TTS) display from these two varying inputs by servo board #1 and the mechanical components of the servo system.

During velocity display, the reference voltage from the ten turn pot, R-601, is a well regulated -6 volts and the velocity voltage from servo board #3 is applied to the emitter of Q-101 on servo board #1. For the TTS display, however, the velocity voltage now becomes the reference voltage for R-601 and the distance output from servo board #5 is the signal input to the emitter of Q-101. (See the Indicator Block Diagram, Figure 7-10.)

These changes are made by the KTS-TTS switch, S-602. When S-602 is set to TTS, the "MIN" flag appears in the lower window and covers the right-hand counter number. The longest time displayed is 59 minutes.

The position of R-601's wiper arm (and the counter dials) depends on the proportion of the velocity voltage applied to R-601 that is required to equal the distance voltage. When R-601's wiper arm is applying the same voltage to Q-102's emitter that is applied to Q-101's emitter by the distance voltage from servo board #5, servo motor M-601 will stop, as discussed with servo board #1. For any distance, if the velocity is zero, as when orbiting a ground station or making bench tests when no change in distance with respect to time, the voltage at the top of R-601 will be zero. The actual time required to reach the destination in this case is infinity, and R-601's wiper arm will be rotated to its upper limit as the servo attempts to find a voltage at the pot arm large enough to match the applied distance voltage.

Many different combinations of distance and velocity may result in the same TTS display. For instance, a distance of 100 nautical miles will generate a distance voltage of about one volt. 200 knots of velocity will generate a velocity voltage of two volts. Therefore, R-601 will be driven to its midpoint to achieve a servo null, corresponding to a display of half of 60 or 30 minutes TTS. Likewise, a distance of 150 nautical miles and a velocity of 300 knots will generate 1.5 and 3 volts, respectively. R-601 will again be driven to its midpoint, causing 30 minutes TTS to be displayed.

For conditions of high velocity and short range, only a small fraction of the velocity voltage across R-601 will be required to equal the low range voltage, so R-601's wiper arm will be driven to a point near ground and a low TTS time will be displayed.

SECTION IV

Installation

4.1 LOCATION CONSIDERATIONS.

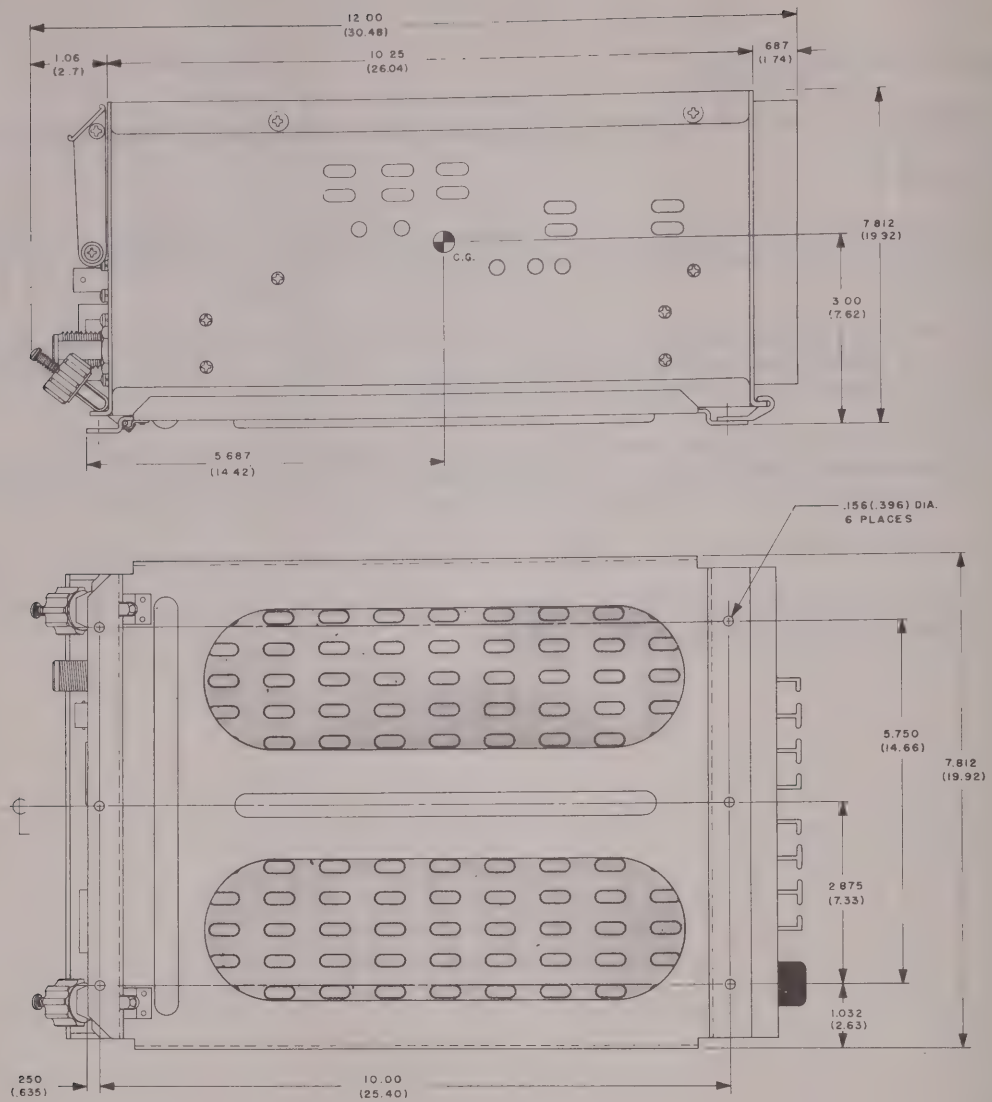
Listed below are factors and suggestions to consider before installing the Cessna DME 800 System.

4.2 INSTALLATION.

1. Your Cessna DME 800 System may be channelled by the 500 or 800 Series Omni, DME 800 Channel Selector or any ARINC 2 out of 5 binary selector head. See Figure 4-1 for binary code selection.
2. The receiver/transmitter may be mounted rigid. Allow one inch free air space around top and back of unit, one-half inch along sides. Avoid mounting close to any high external heat source. Allot adequate space for installation of cables and connectors.
3. The L Band Antenna is used for both the receiver and transmitter sections of the receiver/transmitter. See Figure 4-4 for proper assembly of cable connectors. The antenna should be kept clean; if left dirty (oil covered) the range of the DME may be affected.
4. Refer to Figures 4-2, 4-4, 4-6 and 4-7 for system components installation drawings.
5. Refer to Figure 4-3 for Cessna DME Wiring Diagram and applicable aircraft service manuals for various installation wiring diagrams.

BINARY CODE SELECTION TABLE											
"MC"	---	110	111	112	113	114	115	116	117	108	109
----	"KC"	0	1	2	3	4	5	6	7	8	9
A	F		X	X						X	X
B	G	X	X		X	X					
C	H			X	X		X	X			
D	J					X	X		X	X	
E	K	X						X	X		X

Figure 4-1. Code Selection Table



NOTE:
 1. DIMENSIONS IN PARENTHESES ARE IN CENTIMETERS.
 2. WEIGHT: 11.4 LBS.
 3. MOUNT UNIT RIGID, IN ANY POSITION.
 4. ALLOW 100" FREE AIR SPACE ON TOP AND BACK OF UNIT, .500" FREE AIR SPACE ON SIDES.

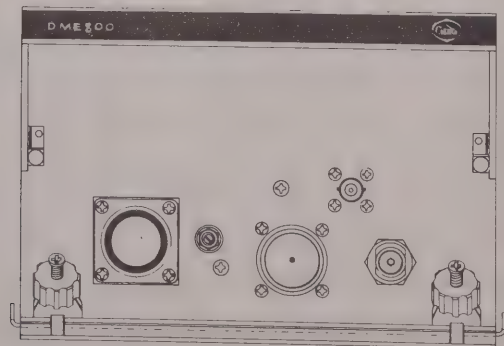
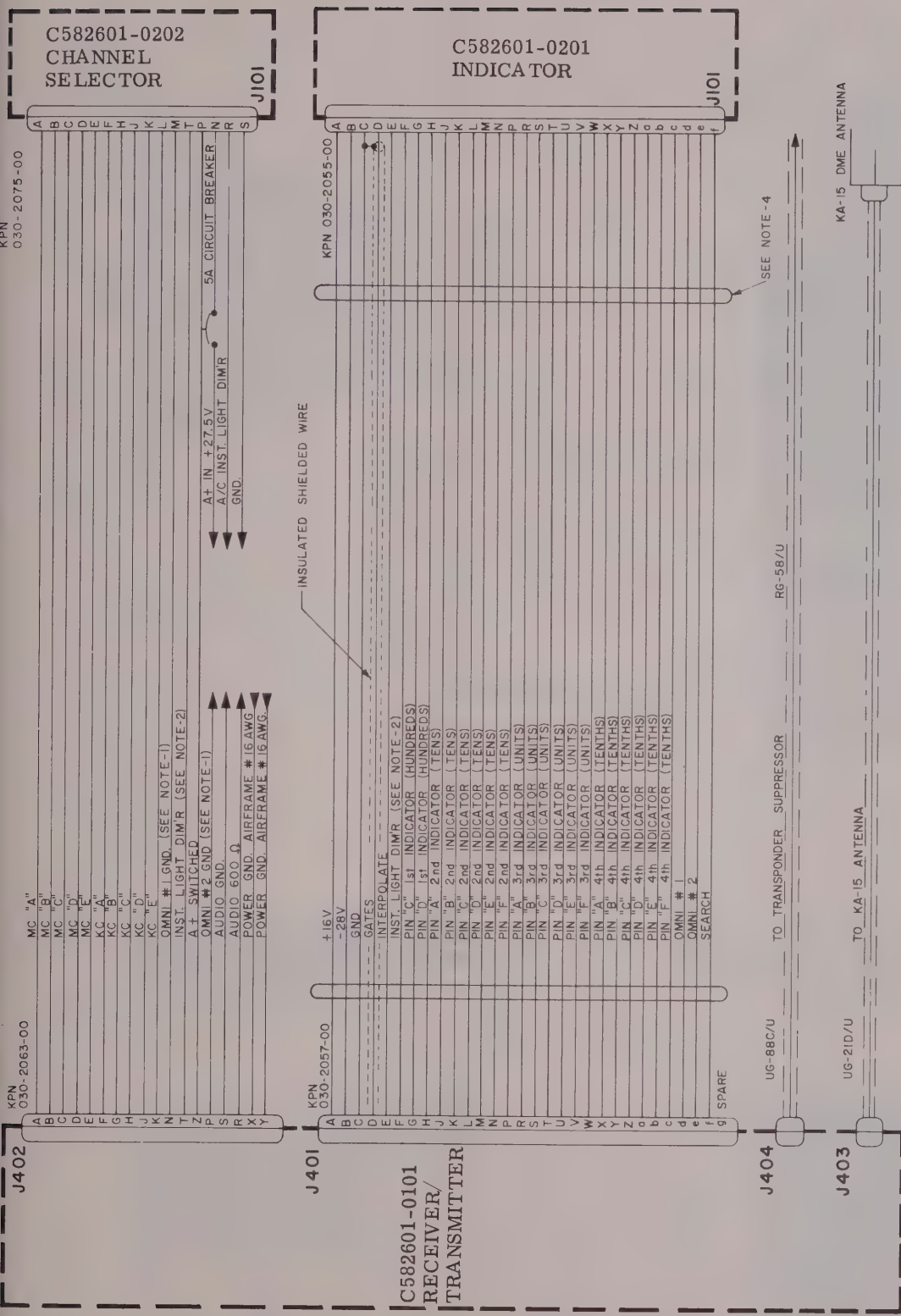


Figure 4-2. Cessna DME 800 Receiver/Transmitter Installation Drawing



- NOTES:
1. CONNECT PIN "M" ON CHANNEL SELECTOR TO EITHER PIN "N" OR "P" ON RECEIVER/TRANSMITTER, OR WHICHEVER IS NOT USED BY ANOTHER SWITCH SELECTOR. IF NO OTHER SELECTOR IS USED WITH THE CHANNEL SELECTOR, CONNECT PINS "N" & "P".
 2. INST. LIGHT DIM'R. CONTROL CAN BE RUN FROM PIN "F" OF INDICATOR TO AIRCRAFT INST. LIGHT DIM'R. CONTROL.
 3. UNLESS NOTED, ALL WIRE SIZE IS #22 AWG MIN.
 4. IF RECEIVER/TRANSMITTER TO INDICATOR CABLING IS TO BE LONGER THAN 5 ft. AND IS IN CLOSE PROXIMITY TO OTHER EQUIPMENT OR CABLES, IT IS RECOMMENDED THAT IT BE LACED OR SLEEVED SEPARATELY AND NOT INTERWOVEN WITH OTHER WIRING.

Figure 4-3. Cessna DME 800 Wiring Diagram

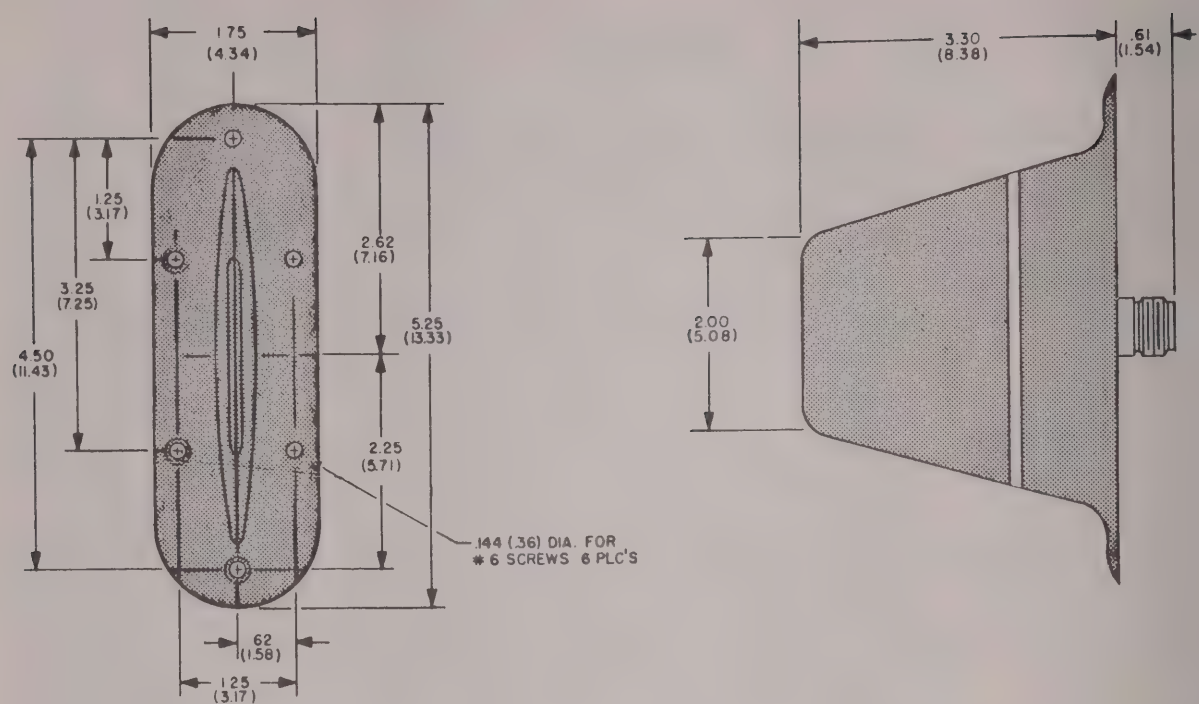


Figure 4-4. Antenna Installation

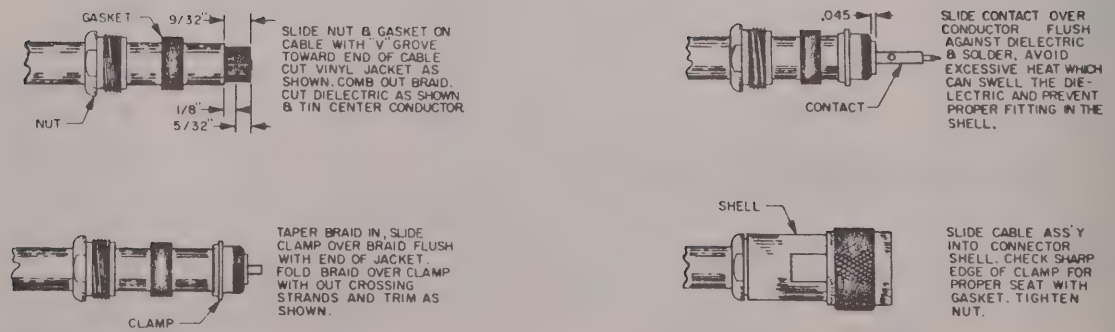
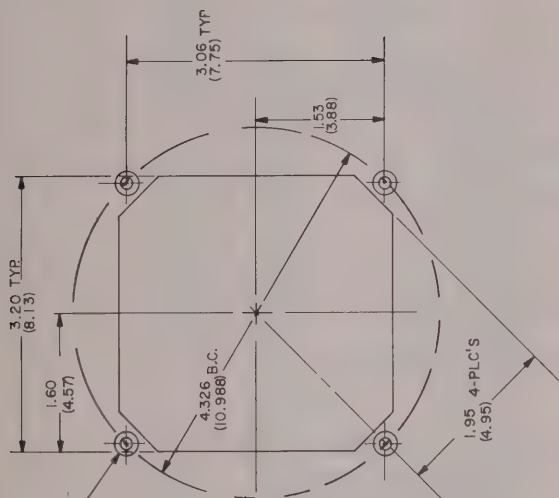
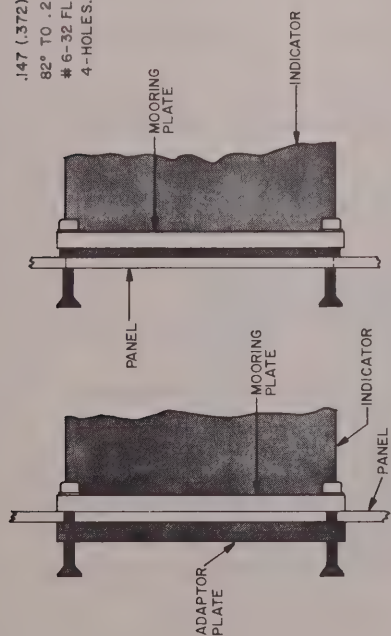


Figure 4-5. Improved "N" Connector Assembly

NOTES:
1. DIMENSIONS IN PARENTHESES
ARE IN CENTIMETERS.



PANEL CUTOUT DIMENSIONS



STANDARD FRONT MOUNTING
STANDARD REAR MOUNTING

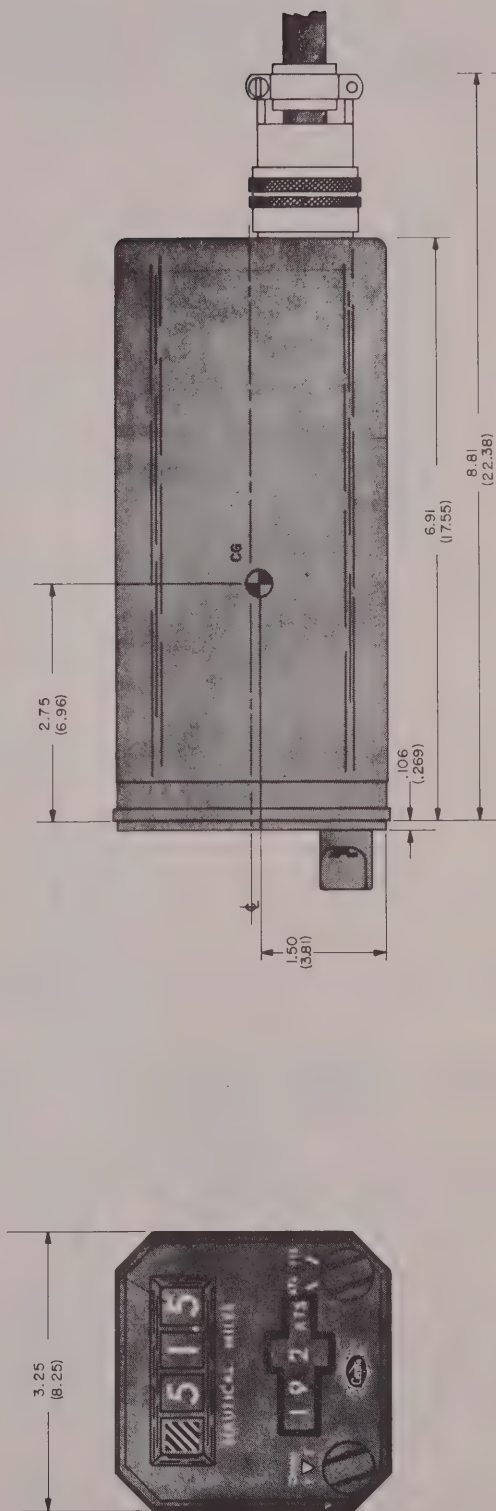


Figure 4-6. Cessna DME 800 Indicator Installation Drawing

NOTES:

1. ALL DIMENSIONS ARE IN INCHES.
DIMENSIONS IN PARENTHESES ARE
IN CENTIMETERS.
2. FOR IN FRONT OF PANEL MOUNTING,
REMOVE THE 4 #6-32 SWAGE NUTS
FROM BACKSIDE OF FRONT MTG. PLATE.

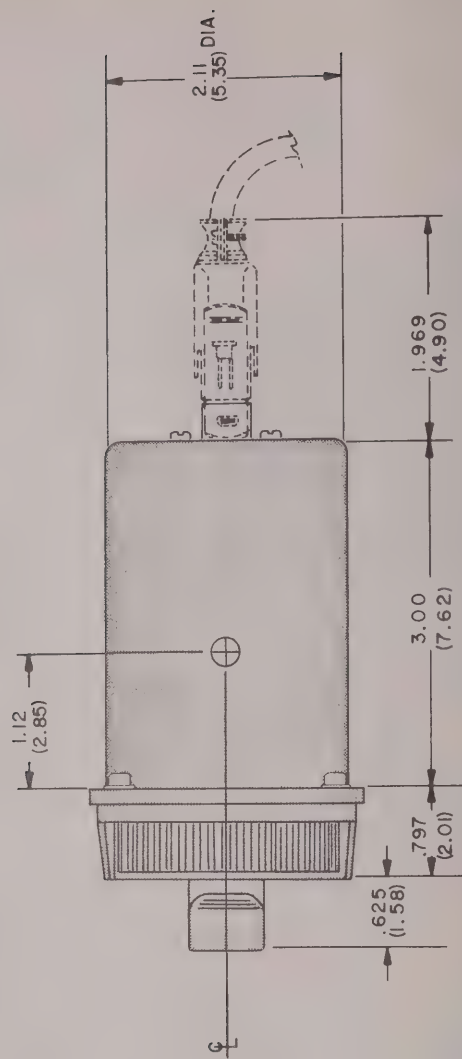
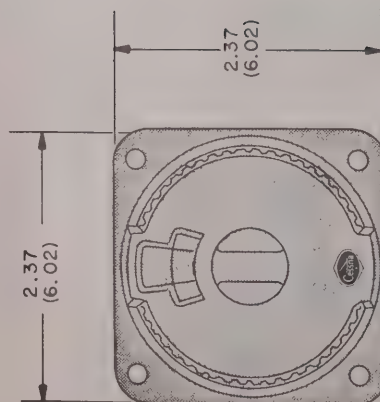
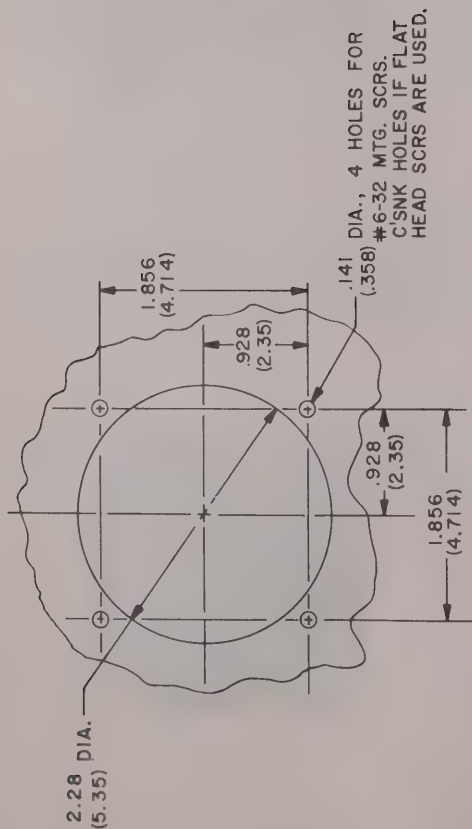


Figure 4-7. Cessna DME 800 Channel Selector Installation Drawing

SECTION V

Maintenance

5.1 GENERAL.

The Maintenance Section serves as a guide in trouble shooting the equipment and making replacements and repairs. This section contains alignment procedures for the operating equipment as well as a generalized trouble shooting chart for locating inoperative sections. Voltage measurements (dc and ac) are on the schematic diagrams in Section VII which may be folded out and used with the following text without flipping pages back and forth.

5.1.1 TEST EQUIPMENT.

Cessna DME 800 Bench Test Kit:

SK320-34.

Signal Generator:

Hewlett Packard 612A or equivalent.

Pulse Generator:

Tel-Instrument T-10B or equivalent.

63 mc Source:

Hewlett Packard 608D or equivalent.

Attentator:

General Radio 874-G10 10 db, 50 ohms, and General Radio 874-G20 20 db, 50 ohms.

Voltmeter Detector:

General Radio 874 VQ modified and calibrated.

Power Supply:

Electron NFB or equivalent; filtered, low impedance, 13.75 volts at 6 amps, and 27.5 volts at 3 amps.

Oscilloscope:

Fairchild-Dumont 766H or equivalent.

VTVM:

RCA Volttohmyst or equivalent.

Precision Voltmeter:

Digitec Series 200 or other meter with accuracy not less than 0.2%.

Associated Cables and R-F Connectors.

Optional:

Peak Power Meter Boonton 8900B or equivalent.

Stop Watch.

5.2 SERVICING NOTES.

The transistor circuits require a certain amount of care when trouble shooting or replacing components. Transistors are particularly sensitive to certain kinds of abuse:

HEAT - When soldering near transistors and diodes, care should be taken not to get the iron against the component. When soldering directly on a transistor lead, hold the lead tightly with pliers between the soldering operation and the transistor body. Use a small soldering tip with a low heat.

CURRENT - The transistor will easily break down under excessive currents. Ground test equipment to the unit when making tests on these circuits. Ground soldering irons to the unit when working on transistor circuits.

5.3 ALIGNMENT AND CALIBRATION -- GENERAL.

CAUTION - Do not attempt alignment until all suggested trouble shooting checks have been made, including all dc (power supply and filament voltage) pulse voltages and test point measurements. If alignment becomes necessary after trouble has been localized and repaired, the following procedure should be carefully followed. Perform only those procedures required to restore normal operation.

PRELIMINARY NOTES:

1. Input voltage to the receiver/transmitter unit (13.75 volts dc or 27.5 volts dc as required).
2. Connect antenna coax for transmitter power measurement or for receiver performance check as shown in Figures 5-2 or 5-3.
3. Location of adjustments and test points are shown in Section VII.
4. Synchronize trigger for scope available at J-404.
5. Use 10X scope probe. (100X for HV modulator pulses.)

6. Set megacycle and deciman selector knobs to frequency indicated.
7. A VHF to UHF frequency Correlation Chart, Figure 5-5, is included for reference.

NOTES: The R-F Section bottom cover must be in place with all screws installed during alignment adjustments. The R-F Section will not function normally with the cover removed.

5.4 R-F UNIT ALIGNMENT.

- a. Check that proper crystals are installed and engaging crystal contacts for each position of mc and kc turrets. (See Figure 5-4.)
- b. To facilitate adjustment, the wire to Pin K on J-405 may be unsoldered and a clip lead attached to Pin K. When no modulator pulses are desired, as when aligning the H-F oscillator or receiver circuits, this clip lead may be grounded. When modulator pulses are required, the grounded end of the clip lead is disconnected and modulator output at the search prf will be present. Be sure to resolder the connection to Pin K when alignment is completed.
- c. Be sure a 50 ohms load is connected to J-403 when the transmitter is being pulsed.
- d. A rough check of multiplier chain operation may be made by noting the presence of negative rectified mixer crystal current at TP-107.

NOTES: Several RF alignment problems have been recognized and can occur if the KHz tweaking shaft is allowed to slip. The tweaking shaft provides slight tuning of the pre-selector and transmitter over the KHz band.

This problem can be identified if the DME alignment continually changes. On the bench, difficulty in balancing the KHz band will be experienced. To verify this condition notice the position of the collar located on the tuning shaft between the 2nd and 3rd preselector cam follower arms. This collar should be in the same mounting configuration (vertically) as all cam follower arms.

When the two set screws at the motor geneva mechanism do not seat tight, they cause a slot to burr into the shaft necessitating replacement of the shaft. Always use the knurled end shaft (P/N 031-0031-01) as a replacement shaft and (P/N 089-6218-04) set screws. Shaft and set screw replacement procedure is as follows:

- (1) Remove the heat sink and rear cover plate from the unit.
- (2) Channel the KHz motor until both set screws holding the KHz shaft to the geneva mechanism are visible. The set screws and drive mechanism near the front of the unit controls the KHz selection. Loosen the two set screws.
- (3) Grasp the KHz shaft at the rear of the radio where it extends through the two motor control wafers, S104 and S105. Remove the shaft from the radio. (If the shaft does not extend through the motor control wafers, it will be necessary to remove the front panel and push the shaft out.)
- (4) Insert the new knurled shaft. (P/N 031-0031-01) It should extend through the geneva mechanism and not rub the front cover plate. Align the motor control wafers to a .0 KHz frequency per figure 14-8 of the maintenance manual. Check the .0 KHz crystal for proper positioning.
- (5) Insert and tighten the set screws (P/N 089-6218-04) and reassemble the radio.
- (6) The RF section alignment should be rechecked per paragraph 5.4 of the maintenance manual.

5.4.1 L-F OSCILLATOR.

- a. No alignment adjustments are required by the L-F Oscillator.
- b. Operation may be checked by connecting a VTVM (-dc scale) to TP-102. With mc crystal temporarily shorted out (as with a screw driver blade), TP-102 should read approximately -0.9 to -1.2 volts for all settings of the kc selector knob.

5.4.2 H-F OSCILLATOR.

- a. The kc knob may be set to any position.
- b. Connect VTVM (-dc scale) to TP-102.
- c. Adjust L-102 at 117 mc and C-103 at 108 mc for maximum VTVM indication.
- d. Repeat until no further improvement is noted.

5.4.3 MIXER V-106B AND AMPLIFIER V-105.

- a. Connect scope probe to TP-104 and extend synchronizer to J-404.
- b. With modulator running, adjust L-108 and L-113 at 117.5 mc and C-118 and C-129 at 108.5 mc for maximum negative pulse amplitude.
- c. Repeat until no further improvement is noted.

5.4.4 TRIPLER GRID V-103.

- a. Connect scope probe to TP-105, extend synchronizer to J-404.
- b. With modulator running, adjust C-137 at 117.5 mc for maximum negative pulse amplitude.

5.4.5 TRIPLER PLATE V-103.

- a. Connect scope probe to TP-106, extend synchronizer to J-404.
- b. With modulator running, adjust C-139, capacitor adjustment screw (vertical) at 117.5 mc for maximum positive amplitude at valley between large plate pulses.
- c. At 108.5 mc, adjust C-139, tracking adjustment screw (horizontal) as in step b.
- d. Repeat steps b and c until no further improvement is noted.

5.4.6. FINAL DOUBLER V-101.

- a. Set up for transmitter power measurement. (See Figure 5-3.)
- b. Adjust C-158, capacitor adjustment screw (vertical), at 117.5 mc for maximum transmitter output.
- c. Adjust C-158, tracking adjustment screw (horizontal), at 108.5 mc for maximum transmitter output.
- d. Repeat steps b and c until no further improvement is noted.
- e. If unable to track and tracking adjustment screw is at counterclockwise limit, carefully spread the parallel wire of L-131 slightly and repeat steps b, c and d, above.
- f. If unable to track and tracking adjustment screw is at clockwise limit, carefully move the parallel wires of L-131 slightly toward each other and repeat steps b, c, and d, above.
- g. Check power at several transmitter frequencies. If power at some point is noted to be below minimum performance standards, alignment may be shifted slightly to obtain adequate overall performance.
- h. On units employing a ceramic planar triode for V-101, its associated cathode cavity may be adjusted as outlined below to increase transmitter power output over a portion of the frequency range if required. Refer to Figure 5-2A for item reference numbers.
 - 1. Insert a long #2-56 screw into one of the empty holes in the top of the end cap (item 9, figure 5-2A) to serve as a handle during adjustment.
 - 2. Loosen the top clamp and the end cap set screw (items 17 and 13, Figure 5-2A).

3. With the transmitter pulsing, adjust the position of the end cap assembly with respect to the housing (item 1, Figure 5-2A).
4. Use caution to avoid shorting the end cap to ground, possibly damaging R-127.
5. After each adjustment of the end cap assembly, check across the transmitter frequency range to determine the effect on power output.
6. When adjustment is completed, tighten the top clamp and end cap set screw and remove the #2-56 screw installed in step 1.

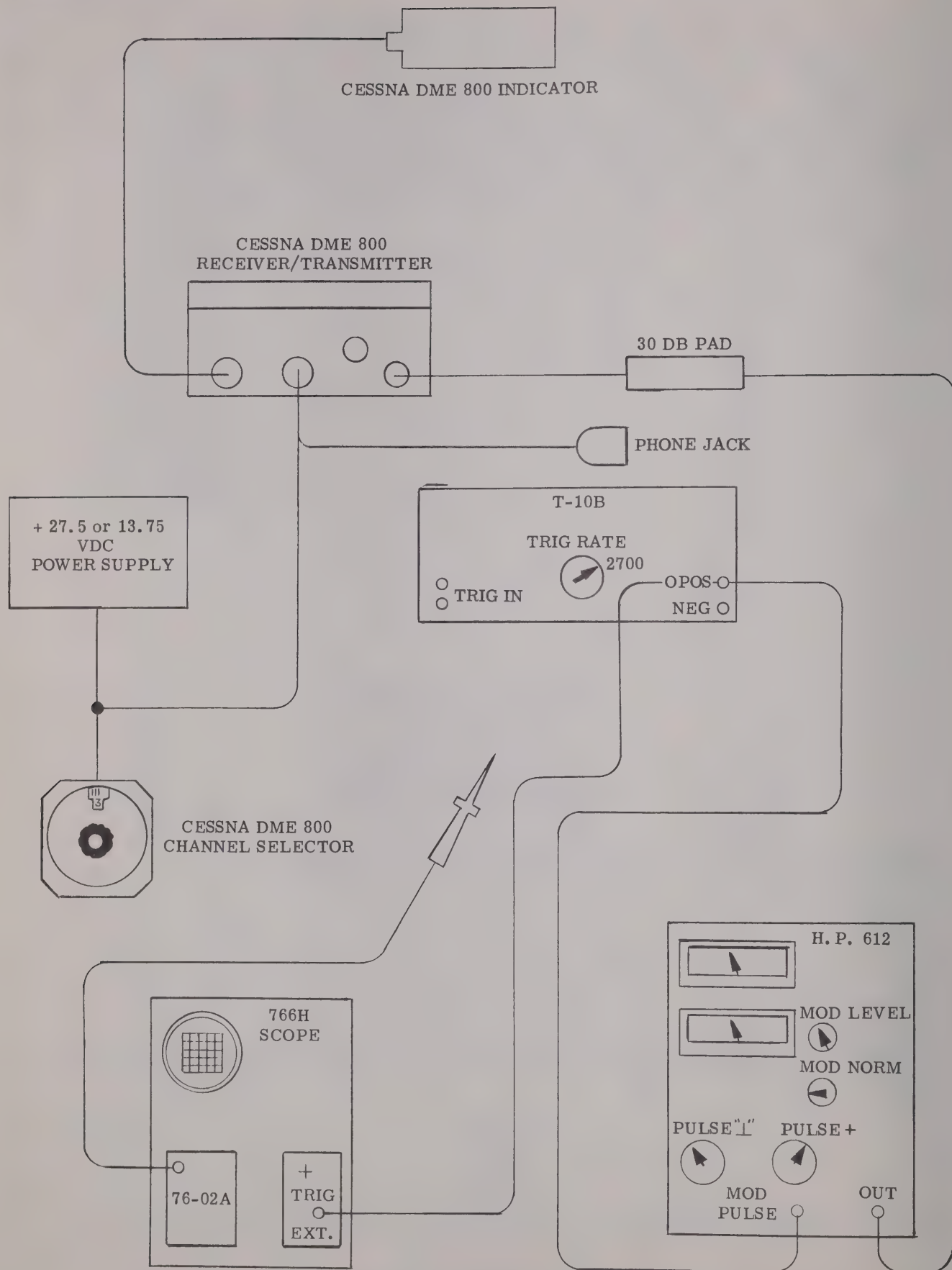
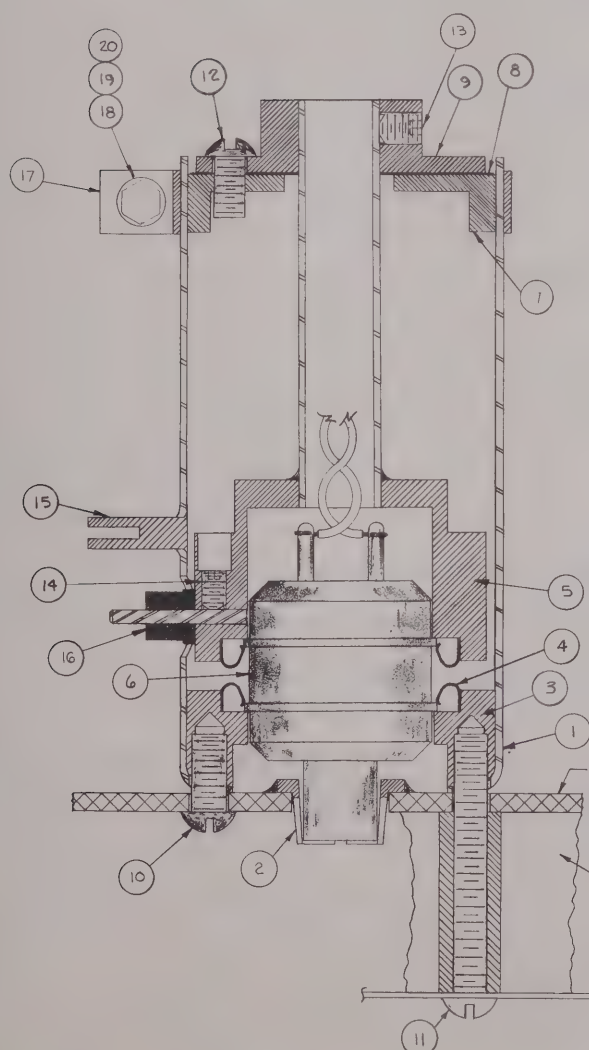


Figure 5-2. Bench Test, Receiver Preselector Alignment and Sensitivity Check

5. 4. 6. 1 REMOVAL OF CERAMIC V-101 FROM CATHODE CAVITY

- a. Unsolder blue filament wires connected to C-178 and C-199.
- b. Remove clamp from top of cavity.
- c. Loosen set screw (item 13) holding end cap to shaft.
- d. Remove end cap from cavity. A #2-56 screw may be inserted in end cap to assist in removal.
- e. Loosen set screw (item 14) holding feed thru terminal (item 16).
- f. Remove feed thru terminal from cavity. Leave connected to coax.
- g. Remove pulse modulator, IF assembly and RF cover plate.
- h. Press on exposed anode of V-101 (item 6) with a blunt tool, allowing removal of V-101 and attached cathode ring assembly (item 5).
- i. Remove tube from cathode ring assembly.
- j. Unsolder filament wires from tube.

For reassembly reverse the above procedure. Recheck alignment.



NOTES:

1. APPLY SILICONE GREASE TO BOTH SIDES OF ITEM 8 BEFORE ASSEMBLY.
2. POSITION OF END CAP ASSY TO BE DETERMINED DURING TESTING PROCEDURES.

250-1056-95		1	
1	089-2009-30	NUT, HEX	20
1	089-4109-30	SPLIT-LOCK WASHER	19
1	089-6024-05	*4-40 ALLEN HEAD	18
1	047-1540-00	CLAMP, TOP	17
1	010-0013-00	TERMINAL, FEED THRU	16
1	008-0035-00	GROUND TERMINAL	15
1	089-5850-04	*1-72 x 1/8" SET SCREW	14
1	089-5853-04	*2-56 x 1/8" SET SCREW	13
3	091-0055-00	*2-56 x 1/16" ROUND HD. NYL	12
1	089-5903-13	*4-40 x 3/16" PAN HD. PH.	11
2	089-5903-03	*4-40 x 3/16" PAN HD. PH.	10
1	076-0203-00	END CAP	9
1	091-0071-00	MICA WASHER	8
1	076-0204-00	END RING	7
1	021-0031-00	VACUUM TUBE	6
1	076-0205-00	CATHODE RING	5
2	090-0112-01	FINGER STOCK	4
1	076-0207-00	GRID RING	3
1	076-0206-00	ANODE CONTACT	2
1	090-0111-01	HOUSING	1
4850	PART NO	DESCRIPTION	ITEM

Figure 5-2A. Cross-Sectional View, V101 Cathode Cavity

5. 4. 7. I-F PREAMPLIFIER ALIGNMENT.

- a. Set up test equipment as in Figure 5-2 after proper operation of I-F Section has been verified.
- b. Connect multimeter of VTVM (+dc scale) to TP-304.
- c. Set selector knobs to 108.5 mc.
- d. Check for crystal current at TP-107.
- e. Inject a 983 mc signal, double pulse modulated at 2700 prf, at J-403 through a 30 db of fixed attenuation.
- f. Optimize 983 mc generator frequency by tuning for peak at TP-304. Keep level at TP-304 below one volt.
- g. Adjust L-132 and L-133 in R-F Section for maximum indication at TP-304.
- h. Repeat step g.

5. 4. 8. RECEIVER PRESELECTOR ALIGNMENT.

- a. Set up test equipment as in Figure 5-2.
- b. Connect multimeter of VTVM (+dc scale) to TP-304.
- c. Set frequency selector knobs to 108.5 mc.
- d. Inject a 983 mc signal, double pulse modulated at 2700 prf, at J-403 through 30 db of fixed attenuation. Tune generator frequency for peak at TP-304.
- e. Adjust capacitor adjustment screws (vertical) on C-151, C-153 and C-154 for peak reading at TP-304. Keep level at TP-304 below one volt.
- f. Set frequency selector knobs to 117.5 mc.
- g. Charge generator frequency to 1209 mc by peaking at TP-304.
- h. Adjust tracking adjustment screws (horizontal) on C-151, C-153 and C-154.
- i. Since interaction exists between the two adjustments, repeat steps c through h until no further improvement is noted.

5. 5 I-F SECTION ALIGNMENT.

5.5.1 OSCILLATOR.

- a. Connect VTVM (+dc scale) to TP-305.
- b. Read approximately +0.6 volts or less at TP-305.
- c. If voltage at TP-305 is significantly higher than +0.6 volts, carefully adjust location of L-310 with a plastic tool to minimize voltage reading.

5.5.2 I-F AMPLIFIER ALIGNMENT.

- a. Terminate signal generator coax cable with a 1/2 watt carbon resistor, 47 ohms to 56 ohms. (See Section III, paragraph 3.2.5 "Detector and Alignment".)
- b. With a 0.001 mfd capacitor in series with the inner conductor, connect to J-411.
- c. Connect VTVM (+dc scale) to TP-302.
- d. Using an accurate frequency reference, adjust the signal generator frequency to 63.0 mc, CW mode.
- e. Peak T-301, T-302, T-304, T-305 and T-306 for maximum VTVM indication.

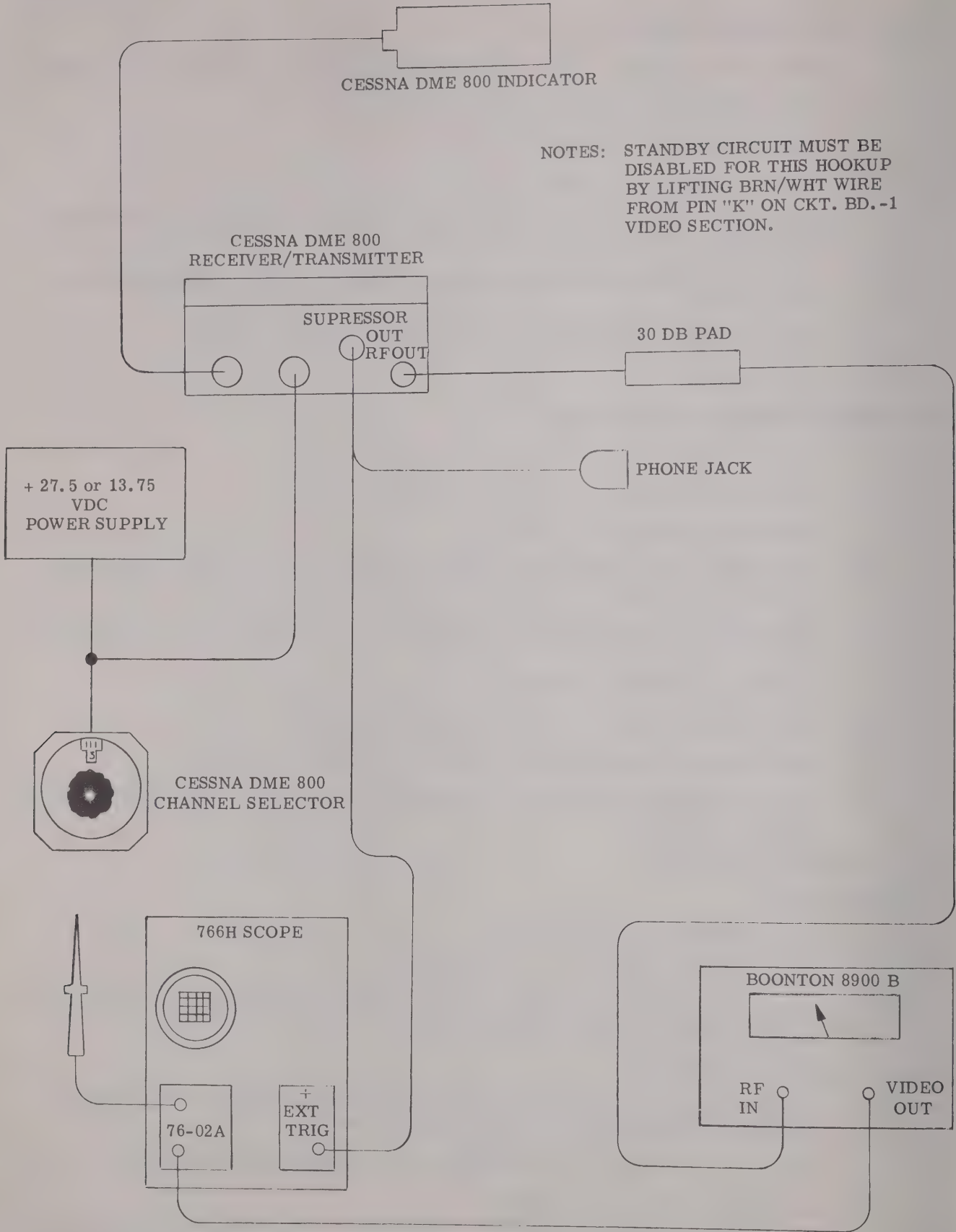


Figure 5-3. Test Set Up for Transmitter Alignment and Power Measurement

- f. Attenuate signal generator output to maintain a dc reading at TP-302 below 0.5 volts throughout alignment. The AGC circuit will respond only to double pulse signals, and higher level CW signals could result in over loading and misalignment.
- g. If direct frequency measuring equipment is not available, interpolate to generator frequency settings for 62.90 and 63.10 mc.
- h. Set the generator at 62.90 mc and adjust T-305 for maximum reading at TP-302.
- i. Set the generator at 63.10 mc and adjust T-302 for maximum reading at TP-302.
- j. Reset the generator at 63.0 mc and repeak T-301, T-304 and T-306.
- k. After alignment, the I-F amplifier should show a band width at the 6 db points of not less than 180 kc and not more than 500 kc.

5.5.3 I-F AMPLIFIER GAIN ADJUSTMENT.

- a. Connect signal generator as in Section IV. Set output level to -86 dbm.
- b. Pulse modulate signal generator, set to 63.0 mc, with a double pulse from T-10B at 2700 prf.
- c. Connect scope probe to TP-303 and scope's external synchronizer input to T-10B output jack. Set sweep to 2 milliseconds per centimeter.
- d. Adjust I-F gain potentiometer, R-325, so that approximately 95% of the pulses are of maximum amplitude. Note that a counterclockwise rotation of R-235 is required to increase gain.

5.5.4 AGC CIRCUIT.

- a. No adjustments are provided for the AGC circuit.
- b. AGC performance may be checked at TP-304 with a multimeter or VTVM set to +dc volts.
- c. With no I-F input signal, TP-304 should read about to .15 volts.
- d. With a double-pulsed 63.0 mc input to the I-F, the voltage at TP-304 should change evenly with changes of input level.

5.6 VIDEO SECTION ALIGNMENT AND CALIBRATION.

Set up system on bench so that it operates in track mode. This may be done either with the conventional test gear or by actually locking to a nearby DME ground station. Place the Initiation Board on the extender card supplied with SK320-34, Cessna DME 800 Bench Test Kit.

5.6.1. PRF ADJUSTMENT.

Adjust R-511 on the Initiation Board so that a Track prf of 26 to 28 per 28 per second is indicated. This may be read directly from the prf meter on a T-10B or indirectly from an average pulse-to-pulse spacing of about 37 milliseconds on a calibrated oscilloscope display.

Check Search prf for a rate between 135 and 150 per second, corresponding to an average pulse spacing of about 7 milliseconds.

NOTE: Some cases of false lock-on of the Cessna 800 DME's are attributed to locking on the 135 cycle reference groups transmitted by a TACAN station. Even though the DME is randomly modulated, when its average SEARCH PRF is 135 pps., it is possible for the interrogations and the TACAN reference signals to become momentarily synchronized. The results would be short term (15 to 30 seconds) false lock-ons by the DME. To alleviate this problem, it is recommended the PRF rate be set in SEARCH for approximately 140 pps. Check to insure the TRACK PRF is not more than 30 pps. When the TRACK PRF is above 30 pps., R504 on the initiation board can be changed from a 681K ohm precision resistor to a 732K ohm precision resistor (PN 136-7323-22).

On Cessna 800 DME units 1394 and below, loss of DME lock-on close to or over the station is normally caused by excessive receiver gain, adjusted by R346 and/or the IF is peaked at 8.47 MHz. These conditions can be corrected by following the broad band IF alignment procedure outlined in this maintenance manual and adjusting the IF gain for -86 dbm sensitivity.

In some cases, the trailing edge of the suppression pulse is not sufficient to hold the pulse blanking transistor Q313 on. This condition allows the unit to develop AGC on its own transmission and desensitize the receiver during the first position of the receiver mode.

Resistor R344 has been changed (when required) from a 18K ohm to a 10K ohm (PN 130-0103-25) to improve the effectiveness of the pulse blanking circuit.

On Cessna DME 800 units 1523 and below, an intermittent lock-on problem, identified by the condition of the DME audio, has been discovered in some Cessna 800 DME's. Intermittent lock-on, in these earlier units, is a result of the TACAN reference burst transmitted to supply Azimuth information to military aircraft. The reference burst is decoded by Q308 and Q309 causing the receiver AGC to erroneously increase, desensitizing the receiver IF strip. When this occurs the audio will sound very broken and unreadable. Corrective procedures are as follows:

Refer to Section VII for further schematic information.

- a. Locate Q309 transistor emitter lead in the IF strip.
- b. Carefully unsolder and lift Q309 emitter lead from ground.
- c. Assemble a .1 uf @ 35 v. capacitor (PN 096-1008-00) and a 470 ohm 1/4 w. (PN 130-0473-25) resistor in parallel.
- d. Observing polarity, carefully solder the positive capacitor side of the assembly to the emitter lead lifted in step 2.
- e. Solder the remaining lead to chassis ground.

No adjustments should be necessary upon completion of this modification.

5.6.2. ZERO MIL CALIBRATION.

This adjustment sets the time delay of the Zero Mile Delay Monostable and is the only adjustment involved in calibration of the ranging circuitry. This delay is factory set at 67.8 microseconds and should not be changed unless proper test equipment is available. Most DME simulators are not accurate enough to which will meet the accuracy requirements.

CALIBRATION WITH AN OSCILLOSCOPE. This method uses the crystal frequency standard interval to the unit to calibrate the time delay of an oscilloscope. The adjustment is then made against the calibrated interval on the oscilloscope.

- a. Connect the "A" trace input and the external synchronizer input (B times base in the case of a Tektronix 545) together with a BNC Tee. Set synchronizer input to +ac, external.
- b. Connect "A" trace input directly to pin "V," J-405. Connect "B" trace probe to pin "X," J-405. Set mode control to alternate A-B trace display.
- c. Set primary time base to 10 microseconds per centimeter and intensified or strobe time base to 1 microsecond per centimeter.
- d. Adjust synchronizer and amplitude controls so that a simultaneous display of the clock gate wave form and a clock output are seen.
- e. With horizontal trace control in strobe (or B intensified by A, depending on the oscilloscope), a brightened trace area should be seen which can be moved across the screen by the delay vernier (or delay time multiplier).
- f. Move the intensified area to the left side of the screen so that the leading edge of the clock gate input is brightened.
- g. Switch to delayed mode. You should now see the edge of the clock gate wave form together with several cycles of the clock wave form.
- h. Count the number of clock cycles from leading edge of the clock gate to the trailing edge. This number should be $54\frac{3}{4}$ cycles. ($54.75 \times 1.237 = 67.8$ microseconds). The unit should be in track mode for this test.
- i. Adjust R-535 for 67.8 microseconds.

CALIBRATION AGAINST A KNOWN DISTANCE GROUND STATION. If a nearby DME ground station is available, determine its distance from your shop by means of accurate maps or survey charts. Remember that the Cessna DME 800 measure nautical miles and that a nautical mile is 6,080 feet as opposed to 5,280 feet in a statute mile.

Connect the DME to an antenna and adjust R-535 accordingly so that the calculated distance is indicated.

NOTE: If the indicated distance is within 0.1 mile, leave the adjustment alone as ground station errors can contribute this much deviation.

5.7 INDICATOR.

Since the alignment of the Cessna DME 800 Indicator requires a properly functioning receiver/transmitter unit, refer to the preliminary alignment notes, Paragraph 5.3 "Alignment and Calibration -- General."

5.7.1 ADJUSTMENT OF TEN TURN POTENTIOMETER (R-601 MAIN FRAME).

If the 10-turn potentiometer or its associated gearing has been removed or replaced in servicing, the potentiometer must be reinstalled in such a fashion that the potentiometer limit and the 000 indication

occur at the same time. This is done in the following manner:

- a. Loosen clamp on left side of indicator with an allen wrench.
- b. Rotate large gear counterclockwise until indicator hits stops at 000 knots.
- c. While holding potentiometer against its CCW stop with a screw driver and large gear against stop with the same hand, retighten clamp with the allen wrench. Check meshing between large and small gears.

5.7.2 VELOCITY REFERENCE ADJUSTMENT (R-101 Servo Board #1).

- a. Bench set up as in Figure 5-2.
- b. Set T-106 "squitter" to "700", "Ground Speed" to "Range". Lock on to an indicated distance of 0.5 nautical miles on the indicator. T-10B "squitter" to "off". Indicator KTS-TTS switch to "KTS".
- c. With a precision voltmeter at TP-501 (between brown-white wire and ground) adjust R-101 to $-6.00 \pm .02$ volts.

5.7.3 VELOCITY ZERO SET (R-303 Servo Board #3).

- a. Set up same as above.
- b. Adjust R-303 (nearest 2 green transistors) for zero indicated speed (clockwise for increase). Allow ample time for creep.
- c. Check manually for a "false zero" (against stop) by moving large gear both ways with finger. A speed zero reading of 0.25 knots or so is acceptable.

5.7.4 DISTANCE VOLTAGE ZERO SET (Servo Board #5).

- a. With unit locked on an indicated distance of 0.5 nautical miles, place the KTS-TTS switch in the "TTS" position.
- b. Place the precision voltmeter on TP-501 (between blue wire and ground).
- c. Adjust R-511 for 0.0 volts out.

5.7.5 VELOCITY CALIBRATION (Servo Board #2).

Before making a velocity calibration from a T-10B, it is advisable to check the accuracy of T-10B velocity. This can be done in the following manner:

- a. Run the T-10B distance potentiometer to maximum, Squitter "700", "Ground Speed" to 300, To-From switch to "To". Allow unit to lock on and track inbound. Move T-10B function switch to "range" to remove all squitter.
- b. With a stop watch, time an indicated (by the indicator) 10 mile change of distance. For example, find the time between the 80.0 mile and the 70.0 mile indication. If the measured time were, say, 2 minutes and 6 seconds, the speed over this range would be :

$$\frac{10 \text{ miles} \times 60 \text{ minutes}}{2.1 \text{ minutes}} = 28.6 \text{ knots (nautical miles per hour).}$$

- c. Reset the T-10B distance to 99 and again track inbound.
- d. As the indicated distance passes through the calibrated 10 mile interval, check the "KTS" indication for agreement with the calibrated speed.
- e. If a significant discrepancy exists, adjust R-209 one-half turn at most (clockwise decrease). The effect of this adjustment will not be noted immediately.
- f. Repeat steps (c) through (f) as much as necessary to insure an accurate calibration.

5.7.6 INTERPOLATE ADJUSTMENT (Servo Board #3).

- a. Set up as above, speed 300 knots, inbound.
- b. On T-10B, switch Trig-Rate to "0". Place Function switch in "Pulse" position for approximately 5 seconds. The unit should interpolate at approximately the same rate of change during this time.
- c. Adjust R-316 for optimum interpolation.

This completes the alignment of the indicator. The following additional checks can be made on completion of repairs to insure a thorough maintenance job.

5.7.7 CHECK SERVO RATE.

- a. Set T-10B direction to "off".
- b. Allow indicated speed to decay to zero.
- c. Place KTS-TTS switch in "TTS" position, allow indicator to run to 59 minutes (upper stop).
- d. Switch back to "KTS" and time the Servo to a zero indication.
- e. This should take 20 seconds maximum.
- f. A longer time than 20 seconds indicates excess mechanical drag or improper servo amplifier operation.

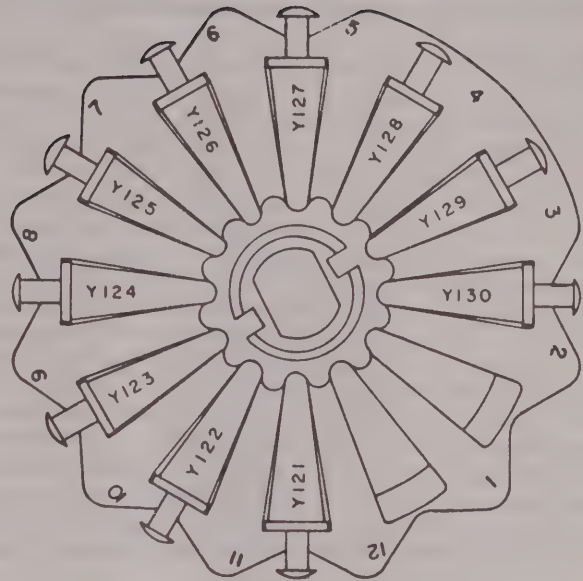
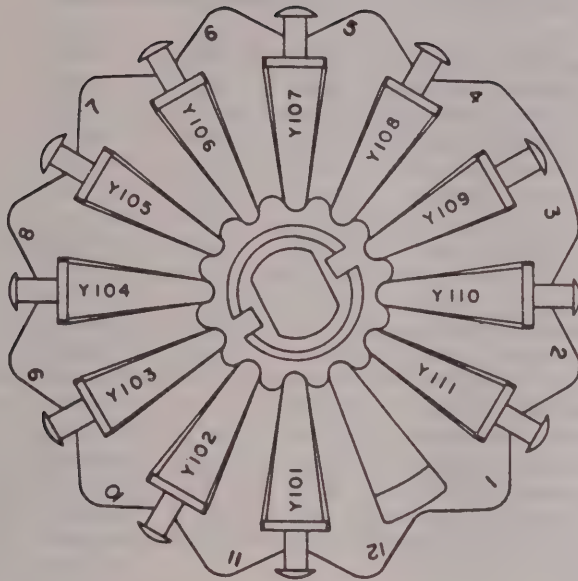
5.7.8 CHECK ZERO-FLAG-ONE INDICATION.

- a. Lock on below 100 miles (check blank).
- b. Place DME in search. Indicator must show Flag.
- c. Lock on greater than 100 miles. (Check "one" indication.)

5.7.9 TTS MATRIX CHECK.

- a. Connect a precision voltmeter to TP-501.
- b. Start T-10B inbound from 99.9 miles with unit tracking. Trig Rate "0", speed 600 knots.
- c. KTS-TTS switch in "TTS" position.
- d. Voltage at TP-501 should correspond with distance as indicated by the indicator. (100 nautical miles = -1.00 volts.)
- e. Check towards zero miles (zero nautical miles = 0 volts) voltage should be within $\pm .04$ volts of indicated distance.

5.7.10 Check for sticky or dragging readouts by operating unit upright and on each side during the above tests.



CRYSTAL NUMBER	CRYSTAL FREQUENCY	CHANNEL FREQUENCY
Y-101	66.8017 Mc	108 Mc
Y-102	67.6350 Mc	109 Mc
Y-103	68.4683 Mc	110 Mc
Y-104	69.3017 Mc	111 Mc
Y-105	70.1347 Mc	112A Mc
Y-106	70.9683 Mc	112B Mc
Y-107	71.8017 Mc	113 Mc
Y-108	72.6350 Mc	114 Mc
Y-109	73.4683 Mc	115 Mc
Y-110	74.3017 Mc	116 Mc
Y-111	75.1347 Mc	117 Mc

CRYSTAL NUMBER	CRYSTAL FREQUENCY	CHANNEL FREQUENCY
Y-121	19.9483 Mc	.0 Mc
Y-122	20.0316 Mc	.1 Mc
Y-123	20.1149 Mc	.2 Mc
Y-124	20.1983 Mc	.3 Mc
Y-125	20.2816 Mc	.4 Mc
Y-126	20.3649 Mc	.5 Mc
Y-127	20.4483 Mc	.6 Mc
Y-128	20.5316 Mc	.7 Mc
Y-129	20.6149 Mc	.8 Mc
Y-130	20.6983 Mc	.9 Mc

NOTE: 1. Crystals are loaded in clockwise sequence. NOTE: 1. Crystals are loaded in clockwise sequence.
 2. Crystal holder shown in 108. position. * 2. Crystal holder shown in .0 position. *

Figure 5-4. Crystal Holder Assemblies

VOR/Relay Signal Frequency Correlation Chart (Ground Station Transmitter)

Mc	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
108	978	979	980	981	982	983	984	985	986	987
109	998	989	990	991	992	993	994	995	996	997
110	998	999	1000	1001	1002	1003	1004	1005	1006	1007
111	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017
112	1018	1019	1020	1157	1158	1159	1160	1161	1162	1163
113	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173
114	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183
115	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193
116	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203
117	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213

VOR/Interrogator Signal Frequency Correlation Chart (Airborne Transmitter)

Mc	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
108	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050
109	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
110	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070
111	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080
112	1081	1082	1083	1094	1095	1096	1097	1098	1099	1100
113	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110
114	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120
115	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130
116	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140
117	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150

Figure 5-5. VHF to UHF Correlation Chart

SECTION VI

Transistor, Diode Cross Reference And Parts List

ALWAYS INCLUDE THE MODEL NO. AND SERIAL NO. OF THE UNIT ALONG WITH THE PART NUMBER AND REFERENCE SYMBOL WITH YOUR ORDER.

NOTES: PNPG denotes Germanium PNP transistor.
NPNS denotes Silicon NPN transistor.
Vceo - DC break down voltage.
Beta - DC current gain.

PART NUMBER

ALTERNATE TRANSISTOR PART NUMBER

007-0001-00	2N628 Transistor, Power, PNPG Motorola
007-0002-00	2N376A Transistor, Power, PNP Motorola
007-0003-00	2N3615 Transistor, Power, PNPG Motorola
007-0004-00	2N1537 Transistor, Power, PNP Motorola
007-0007-00	2N618 Transistor, Power Motorola
007-0008-00	2N2067 Transistor, Power, PNP Clevite Corp.
007-0010-00	2N1517 Transistor, SELECTED PNPG Amperex, Inc. (OC-169)
007-0012-00	2N1515 Transistor, (OC-171) PNP, Amperex, Inc.
007-0013-00	2N1372 Transistor, Audio, PNP, Texas Inst., Inc.
007-0014-00	2N1545 Transistor, Power, PNP, Motorola
007-0016-00	2N1515 Transistor, SELECTED, PNP, Amperex, Inc. (OC-169)
007-0017-00	USE 007-0001-00
007-0018-00	2N1540 Transistor, Power, PNP, Motorola (Beta 50/100)
007-0019-00	SM554 Transistor, NPNS Motorola
007-0020-00	2N1540 Transistor, SELECTED PNP, Bendix (Beta Min. 100)
007-0021-00	SE1001 Transistor, NPNS, Fairchild Semiconductor
007-0023-00	GA2182 Transistor, PNPG, Texas Instrument
007-0025-00	DELETE FROM ALL PARTS LISTS; USE 007-0031-00
007-0025-01	DELETE FROM ALL PARTS LISTS; USE 007-0031-00
007-0025-02	DELETE FROM ALL PARTS LISTS; USE 007-0031-00
007-0026-00	DELETE FROM ALL PARTS LISTS; USE 007-0026-02 OR BETTER
007-0026-01	B339 White Dot SELECTED, NPNS, G. E. (Beta 75/225, Vceo 16V)
007-0026-02	B340 Violet Dot SELECTED, NPNS, G. E. (Beta 75/225, Vceo 26V)
007-0026-03	B341 Blue Dot SELECTED, NPNS, G. E. (Beta 75/225, Vceo 50V)
007-0028-00	SE3001 Transistor, NPNS, Fairchild Semiconductor
007-0029-01	2N1542 Transistor, PNP, Motorola (Beta 100 Min.)
007-0030-00	2N3054 Transistor, 35839, NPNS, R.C.A.
007-0031-00	A335, Orange Dot, NPNS, G. E. (Vceo 22V), (Beta 90/180)
007-0032-00	A336, Yellow Dot, NPNS, G. E. (Beta 150/300, Vceo 22V)
007-0033-00	A337, Green Dot, NPNS, G.E. (Beta 235/470, Vceo 22V)
007-0034-00	B342, Red Dot, NPNS, G.E. (Beta 30/90, Vceo 22V)
007-0035-00	B343, Brown Dot, NPNS, G.E. (Beta 180/540, Vceo 22V)
007-0036-00	SK7405, Gray Dot, NPNS, G.E. (Beta 35/70, Vceo 30V)
007-0038-00	2N3053, Transistor, 40053, R.C.A.
007-0039-00	2N3403, Transistor, NPNS, G.E.
007-0040-00	2N1760, Transistor, PNPG, Clevite
007-0041-00	2N2290, Transistor, PNPG, Bendix
007-0042-00	2N699, Transistor, NPNS, Transistron Elect. Corp./General Inst. Corp.
007-0043-00	2N1671B, Transistor, Unijunction, Texas Inst.
007-0044-00	2N2646, Transistor, Unijunction, G. E.
007-0045-00	TI3031, Transistor, Power, PNPG, Texas Inst.
007-0046-00	I6J1, Transistor, PNP, G.E.
007-0047-00	2N3638, Transistor, NPNS, Fairchild Semiconductor
007-0048-00	2N2147, Transistor, PNPG, R.C.A.
007-0049-00	2N706A, Transistor, NPNS, R.C.A.
007-0050-00	2N3568, Transistor, NPNS, Fairchild Semiconductor
007-0051-00	2N1893, Transistor, 38852, NPNS, R.C.A.

PART NUMBER

ALTERNATE TRANSISTOR PART NUMBER

007-0052-00	2N3639, Transistor, NPNS, Fairchild semiconductor
007-0053-00	2N3688, Transistor, SE5001, Fairchild Semiconductor
007-0054-00	2N3478, Transistor, NPNS, R.C.A.
007-0055-00	2N3564, Transistor, NPNS, Fairchild Semiconductor
007-0056-00	B10882, Transistor, PNPG, Bendix
007-0058-00	2N3055, Transistor, NPNS, R.C.A. Bendix
007-0059-00	2N3702, Transistor, PNPS, Texas Inst.
007-0060-00	2N3640, Transistor, NPNS, Fairchild Semiconductor
007-0061-00	TIS34, Transistor, FET, Texas Inst.
007-0063-00	DTG1011, Transistor, PNPG, Delco Radio
007-0064-00	SE5020, Transistor, NPNS, Fairchild Semiconductor
007-0065-00	2N3906, Transistor, PNPS, Motorola
007-0066-00	2N3866, Transistor, NPNS, R.C.A.
007-0067-00	2N3440, Transistor, NPNS, R.C.A.
007-0068-00	2N3441, Transistor, NPNS, R.C.A.
007-0069-00	2N3933, Transistor, NPNS, R.C.A.
007-0070-00	PT3125D, Transistor, NPNS, TRW
007-0071-00	PT3125E, Transistor, TRW
007-0072-00	2N3773, Transistor, NPNS, R.C.A. Westinghouse, Electric, Solitron Devices, Inc.
007-0073-00	SF4365, Transistor, FET, Texas Inst.
007-0074-00	NPNS, R.C.A.
007-0075-00	40362, Transistor, PNPS, R.C.A.
007-0076-00	SK5510, Transistor, PNPS, Texas Inst.
007-0077-00	PT3125C, Transistor, NPNS, TRW
007-0078-00	2N3415, Transistor, NPNS, G.E.
007-0079-00	2N3819, Transistor, FET, Texas Inst.
007-0080-00	TIS43, Transistor, Unijunction, Texas Inst.
007-0081-00	2N4037, Transistor, PNPS, R.C.A.
007-0082-00	2N4062, Transistor, PNPS, Texas Inst.
007-0083-00	40392, Transistor, NPNS, R.C.A.
007-0084-00	40394, Transistor, NPNS, R.C.A.
007-0085-00	Transistor, PNPG
007-0086-00	TIS58, Transistor, Yellow, FET, Texas Inst. (I_{dss} $2\frac{1}{2}$ -5ma)
007-0087-00	TIS58, Transistor, Green, FET, Texas Inst. (I_{dss} 4-8ma)
007-0087-01	TIS59, Transistor, Green, FET, Texas Inst. (I_{dss} 10-25ma)
007-0090-00	3N128, Transistor, MOSFET, R.C.A.
007-0091-00	2N4255, Transistor, NPNS, Texas Inst.
007-0093-00	SK7905, Transistor, NPNS, Texas Inst.
007-0094-00	PT3135C, Transistor, NPNS, TRW
007-0095-00	PT3135D, Transistor, NPNS, TRW
007-0096-00	PT3135E, Transistor, TRW
007-0098-00	40348, Transistor, NPNS, R.C.A.
007-0099-00	2N4348, Transistor, NPNS, R.C.A.
007-0100-00	TN80, Transistor, Sprague Electric Co.
007-0104-00	40422, Transistor, NPN, R.C.A.
007-0105-00	40412, Transistor, NPN, R.C.A.
007-0107-00	MPF104, Transistor, N-Chan., FET, Motorola
007-0110-00	PS80, Transistor, Sprague Electric Co.
007-0111-00	UC814, Transistor, P-Chan., FET, Union Carbide Electronics
007-0112-00	38851, Transistor, NPNS, R.C.A.
007-0113-00	2N3646, Transistor, NPN, Fairchild Semiconductor
007-0115-00	2N5037, Transistor, NPNS, R.C.A.
007-0116-00	SK8696, Transistor, NPNS, Texas Inst.
007-0117-00	3N140, Transistor, N-Chan., MOSFET, R.C.A.
007-0118-00	40468, Transistor, N-Chan., MOSFET, R.C.A.
007-0119-00	2N4917, Transistor, PNPS, Fairchild Semiconductor
007-0120-00	TA7153, Transistor, MOSFET, R.C.A.
007-0123-00	FPT100, Transistor, Light Detector, Fairchild Semiconductor
007-7000-00	SN7490N, B. C. Decade Counter, Texas Inst.
007-7001-09	MC790P, Dual J-K, Flip-Flop, Motorola
007-7001-13	MC799P, Dual Buffer, Motorola
007-7002-02	MC824P, Quad 2-Input Gate, Motorola
007-7002-03	MC825P, Dual 4-Input Gate, Motorola

PART NUMBER

ALTERNATE TRANSISTOR PART NUMBER

007-7002-06
007-7002-07
007-7003-00

MC885P, Quad 2-Input Expander, Motorola
MC886P, Dual 4-Input Expander, Motorola
TFF3131 (TYPE), Transistron Elect. Corp., 2-Input Master Slave,
J-K Flip-Flop

DIODE CROSS REFERENCE

PART NUMBER

ALTERNATE DIODE PART NUMBER

007-4001-00
007-4002-00
007-4003-01
007-5002-00

Capacitor, 145pf, @-4V, Transistron Electronic Corp.,
Computer Diodes Corp. VVC 115
Silicon, Varactor, 32.7pf, @ 9.0V, MC117, Motorola Only
Voltage, Variable, Capacitor, 500pf, @-2V, PQ1003, TRW
1N4739, Zener, 9.1V, 1 Watt, 10%, North American Electric Co.,
Diodes, Inc., Motorola,
Semcor Div-Components, Inc.

007-5003-00
007-5004-00
007-5005-00
007-5006-00
007-5007-00

1N4737, Zener, 7.5V, 1 Watt, 10%, Same as 007-5002-00
1M14ZS10, Zener, 14V, 1 Watt, 10%, Same as 007-5002-00
1N935A, Zener, 9V, $\frac{1}{2}$ Watt, 5%, Motorola
1N957, Zener, 6.8V, .4 Watt, 20%, Motorola
1N1588, Zener, 3.9V, $3\frac{1}{2}$ Watt, 10%, North American Elect.
International Rectifier

007-5008-00
007-5009-00

1N963, Zener, 12V, .4 Watt, 20%, Motorola
1N4745, Zener, 16V, .2 Watt, 10%, Motorola, North American Elect. Inc.,
Diodes, Inc., Semcor-Div Components,
Inc. (LMZ-16)

007-5010-00

1N3002B, Zener, 75V, 10 Watt, 5%, International Rectifier Corp.,
Diodes, Inc., Semiconductor, Texas
Inst., Semcor-Div Components,
Transistron Electric Corp.

007-5011-00

AN362, Zener, 6.2V, 1 Watt, 5%, Semcor-Div Components, Inc.,
North American Elect., Inc.,
Diodes, Inc., Motorola

007-5011-01
007-5011-02
007-5011-03
007-5011-04
007-5011-05
007-5011-06
007-5011-08
007-5011-09
007-5011-10
007-5011-15
007-5011-16
007-5011-19
007-5011-20
007-5011-21
007-5014-00
007-5016-00
007-6004-00

Zener, 10V, 1 Watt, 5%, Same as 007-5011-00
AN364, Zener, 12V, 1 Watt, 5%, Same as 007-5011-00
Zener, 16V, 1 Watt, 5%, Same as 007-5011-00
Zener, 13V, 1 Watt, 5%, Same as 007-5011-00
Zener, 3.3V, 1 Watt, 5%, Same as 007-5011-00
Zener, 4.7V, 1 Watt, 5%, Same as 007-5011-00
Zener, 8.2V, 1 Watt, 5%, Same as 007-5011-00
Zener, 3.6V, 1 Watt, 5%, Same as 007-5011-00
Zener, 22V, 1 Watt, 5%, Same as 007-5011-00
Zener, 7.5V, 1 Watt, 5%, Same as 007-5011-00
Zener, 9.1V, Watt, 5%, Same as 007-5011-00
Zener, 18V, 1 Watt, 5%, Same as 007-5011-00
Zener, 20V, 1 Watt, 5%, Same as 007-5011-00
Zener, 24V, 1 Watt, 5%, Same as 007-5011-00
1N976, Zener, 43V, .4 Watt, 20%, Motorola
Zener, 5.1V, 1 Watt, 5%, Semcor-Div Components, Inc., Motorola
Germanium PIV 75V, DR780, General Inst. Corp.; OMC451, Ohmite Mfg.
Co.

007-6006-00
007-6007-00

Silicon Rectifier PIV, DI26, Diodes, Inc.; PA071, General Inst. Corp.
1N461, Silicon, PIV, 20V, General inst. Corp.
SG701, Silicon, PIV, 20V, Transistron Elect. Corp.
S198, Silicon, PIV, 20V, National Transistor/ITT Semiconductor
1N456A, Silicon, PIV, 20V, Sylvania Electric Products
1N461, Silicon SELECTED, General Inst. Corp.
1N458A, Min. PIV, 70V, Raytheon
SG701, Transistron Electric Corp.

007-6009-00

OMC712, Germanium, Min PIV, 25V, Ohmite Mfg. Corp.

PART NUMBER

ALTERNATE DIODE PART NUMBER

007-6015-00	S312, Silicon, Min PIV, 20V, National Transistor/ITT Semiconductor AD1090, American Micro Devices, Inc.
007-6016-00	1N4009, Silicon, G. E., Min. PIV, 25V, Transitron Elect. Corp.
007-6016-01	1N4009, SELECTED, Transitron Elect. Corp.
007-6017-00	1N82AG, Silicon, Point Contact, Sylvania Electric Products
007-6018-00	145A2, Silicon Controlled, Texas Inst. TCR-205C, Rectifier, Transitron Elect. Corp.
007-6019-00	SG5294, Silicon, Transitron Elect. Corp.
007-6020-00	1N459, Silicon, Sylvania Electric Products
007-6021-00	TS-2, Silicon Rectifier, Diodes, Inc.
007-6022-00	TS-6, Silicon Rectifier, Diodes, Inc.
007-6023-00	1N277, Germanium, Transitron Elect. Corp. Min. PIV, 125V, Erie Technological Products, Sylvan Electric Products
007-6024-00	1N4001, Silicon Rectifier, Min. PIV, 50V, Motorola
007-6025-00	1N4003, Silicon Rectifier, Min. PIV, 200V, Motorola
007-6026-00	1N3752, Silicon Rectifier, DI410 PIV, 1000V, Diodes, Inc.
007-6027-00	TCR74, Silicon Controlled Rectifier, Transitron Elect. Corp.
007-6028-00	1N3757, Silicon Rectifier, DI76, Diodes, Inc.
007-6029-00	1N457A, Silicon, Min PIV, 60V, Transitron Elect. Corp., Sylvania Electric Products, Erie Technological Products
007-6029-01	1N457A, SELECTED, Same as previous part
007-6030-00	1N3645, High Voltage Rectifier, International Resistance Co. 50D20, Atlantic Semiconductor
007-6031-00	TIXV304, Silicon, Texas Inst.
007-6032-00	1N484B, Silicon, Sylvania Electric Products, Transitron Elect. Corp. Erie Technological Products
007-6033-00	1N270, Germanium, Transitron Elect. Corp.
007-6034-00	1N3064, Silicon, G. E.
007-6035-00	1N816, Silicon, Transitron Electric Corp.
007-6035-01	1N816, Kit, SELECTED
007-6036-00	TCR764, Special Silicon Controlled-Rectifier, Transitron Elect.
007-6037-00	SG3472, Silicon, Transitron Elect. Corp.
007-6038-00	TIV305, Metal Silicon, Texas Inst.
007-6039-00	40525, Gate Controlled Switch, R.C.A.
007-6040-00	HPA8646, Silicon PIN Diode, Hewlett-Packard HP3039, Silicon PIN Diode, Hewlett-Packard

ALWAYS INCLUDE THE MODEL NO. AND SERIAL NO. OF THE UNIT ALONG WITH THE PART NUMBER AND REFERENCE SYMBOL WITH YOUR ORDER.

RECEIVER/TRANSMITTER

R-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-101	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-102	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-103	Capacitor, Variable, .7-3.0pf, 300 WVDC	102-0010-01
C-104	Capacitor, Ceramic, 20pf, 5%, 400 WVDC, N150	113-3200-00
C-105	Capacitor, Ceramic, 10pf, 5%, 400 WVDC, N150	113-3100-00
C-106	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-107	Capacitor, Ceramic, 2.2pf, 10%, 400 WVDC, N150	113-5022-00
C-108	Capacitor, Ceramic, 4.7pf, 5%, 400 WVDC, N150	113-3047-00
C-109	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-110	Capacitor, Ceramic, 470pf, 20%, 400 WVDC, X5F	113-7471-00
C-111	Capacitor, Ceramic, 470pf, 20%, 400 WVDC, X5F	113-7471-00
C-112	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-113	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-114	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-115	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-116	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-117	Capacitor, Ceramic, 8.2pf, 5%, 400 WVDC, N150	113-3047-00
C-118	Capacitor, Variable, .7-3.0pf, 350 WVDC	102-0010-01
C-119	Capacitor, Ceramic, 27pf, 5%, 400 WVDC, N150	113-3270-00
C-120	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-121	Capacitor, Ceramic, 470pf, 20%, 400 WVDC, X5F	113-7471-00
C-122	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-123	Capacitor, Ceramic, 300pf, 10%, 400 WVDC, X5F	113-5301-00
C-124	Capacitor, Molded 1.0pf, 10%, 500 WVDC	106-0001-01
C-125	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0005-50
C-126	Capacitor, Ceramic, 300pf, 10%, 400 WVDC, X5F	113-5301-00
C-127	Capacitor, Ceramic, 300pf, 10%, 400 WVDC, X5F	113-5301-00
C-128	Capacitor, Ceramic, 4.7pf, 5%, 400 WVDC, N150	113-3047-00
C-129	Capacitor, Ceramic, .7-3.0pf, 350 WVDC	102-0010-01
C-131	Capacitor, Ceramic, 27pf, 5%, 400 WVDC, N150	113-3270-00
C-132	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0004-01
C-133	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0005-50
C-134	Capacitor, Feed Thru, 100pf, 20%, 1400 VAC	106-0009-00
C-135	Capacitor, Ceramic, 27pf, 5%, 400 WVDC, N150	113-3270-00
C-136	Capacitor, Ceramic, 1.9pf, 10%, 400 WVDC, N330	113-5019-01
C-137	Capacitor, Variable, .8-2.0pf, 750 WVDC	102-0012-00
C-138	Capacitor, Ceramic, 1.9pf, 10%, 400 WVDC, N330	113-5019-01
C-139	Capacitor, Variable, Split Stator	102-0014-00
C-140	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0005-50
C-141	Mica Insulator, 75pf to ground	019-0026-00
	Tripler Plate Tank, 75pf to ground	250-1056-01
C-142	Capacitor, Molded, .68pf, 10%, 500 WVDC	106-0001-08
C-143	Capacitor, Feed Thru, 100pf, 20%, 1400 VAC	106-0009-00
C-144	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0005-50
C-145	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
C-146	Capacitor, Feed Thru, 100pf, 20%, 500 WVDC	106-0004-01
C-147	Capacitor, Ceramic, 56pf, 5%, 400 WVDC, N150	114-3560-00
C-148	Capacitor, Ceramic, 33pf, 5%, 400 WVDC, N150	113-3330-00
C-149	Capacitor, Molded, .47pf, 10%, 500 WVDC	106-0001-00
C-150	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-151	Capacitor, Variable Glass Dielectric	102-0021-00
C-152	Capacitor, Molded, 1.0pf, 10%, 500 WVDC	106-0001-01
C-153	Capacitor, Variable, Glass Dielectric	102-0021-00
C-154	Capacitor, Variable, Glass Dielectric	102-0021-00
C-155	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00

R-F SECTION

REF. SECTION	DESCRIPTION	PART NUMBER
C-156	Capacitor, Molded, .47pf, 10%, 500 WVDC	106-0001-00
C-157	Capacitor, Molded, .56pf, 10%, 500 WVDC	106-0001-15
C-158	Capacitor, Variable, Glass Dielectric	102-0021-00
C-159	Capacitor, Feed Thru, 100pf, 20%, 1400 VAC	106-0009-00
C-161	Capacitor, Feed Thru, 100pf, 20%, 1400 VAC	106-0009-00
C-162	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-163	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-164	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-165	Capacitor, Molded, 1.5pf, 10%, 500 WVDC	106-0001-02
C-166	Capacitor, Ceramic, 56pf, 5%, 400 WVDC, N150	114-3560-00
C-167	Capacitor, Ceramic, 150pf, 10%, 400 WVDC, X5F	113-5151-01
C-168	Capacitor, Ceramic, 56pf, 5%, 400 WVDC, N150	114-3536-00
C-171	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-172	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-173	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-174	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-175	Capacitor, Ceramic, 1Kpf, GMV, 400 WVDC, Z5U	113-8102-00
C-176	Capacitor, Ceramic, 1Kpf, GMV, 400 WVDC, Z5U	113-8102-00
C-177	Capacitor, Ceramic, 1Kpf, GMV, 400 WVDC, Z5U	113-8102-00
C-178	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-179	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-180	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-181	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-182	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0004-02
C-183	Capacitor, Ceramic, 1Kpf, GMV, 400 WVDC, Z5U	113-8102-00
C-184	Capacitor, Ceramic, 470pf, 20%, 400 WVDC, X5F	113-7471-00
C-185	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-186	Capacitor, Ceramic, 1Kpf, 400 WVDC, X5F	113-5102-00
C-187	Capacitor, Ceramic, .1Kpf, 20%, 500 WVDC	106-0004-02
C-188	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-190	Capacitor, Feed Thru, 1Kpf	106-0008-00
C-192	Capacitor, Feed Thru, 1Kpf	106-0008-00
C-193	Capacitor, Feed Thru, 1Kpf	106-0008-00
C-194	Capacitor, Feed Thru, 1Kpf	106-0008-00
C-195	Capacitor, Tantalum, 1.0uf, 20%, 35 WVDC	096-1005-00
C-196	Capacitor, Tantalum, 1.0uf, 20%, 35 WVDC	096-1005-00
C-197	Capacitor, Feed Thru, 1k, 20%, 500 WVDC	106-0006-05
C-198	Capacitor, Feed Thru, 1k, 20%, 500 WVDC	106-0006-05
C-199	Capacitor, Feed Thru, 1k, 20%, 500 WVDC	106-0006-05
CR-101	Diode, Silicon	007-6017-00
*CR-102	Diode, Germanium	007-6023-00
**	Diode Silicon	007-6040-00
L-101	Variable, Inductor (HF Oscillator)	031-0014-04
L-102	Coil, HF Oscillator Tracking	019-2033-01
L-103	Choke, RF, 2.2uh, 10%	019-2055-20
L-104	Choke, RF, .68uh, 10%	019-2055-14
L-105	Choke, RF, 2.0uh, 5%	
L-106	Choke, RF, 2.2uh, 10%	
L-107	Variable Inductor Mixer	019-2055-20
L-108	Coil, Mixer Tracking	031-0014-05
L-111	Choke, RF, 4.7uh, 10%	019-2033-00
L-112	Variable Inductor, (Amplifier)	019-2058-20
L-113	Coil, Amplifier Tracking	031-0014-05
L-114	Choke, RF, 4.7uh, 10%	019-2033-00
L-115	Choke, RF, 2.0uh, 10%	019-2058-20
L-116	Inductor, Tripler Grid Wire, 2-3/8", #22 AWG	019-2062-00
L-117	Variable Inductor	
L-118	Inductor, Tripler Grid Wire, 2-3/8", #22 AWG	031-0014-03

*Cessna DME 800 units 1400 and below.

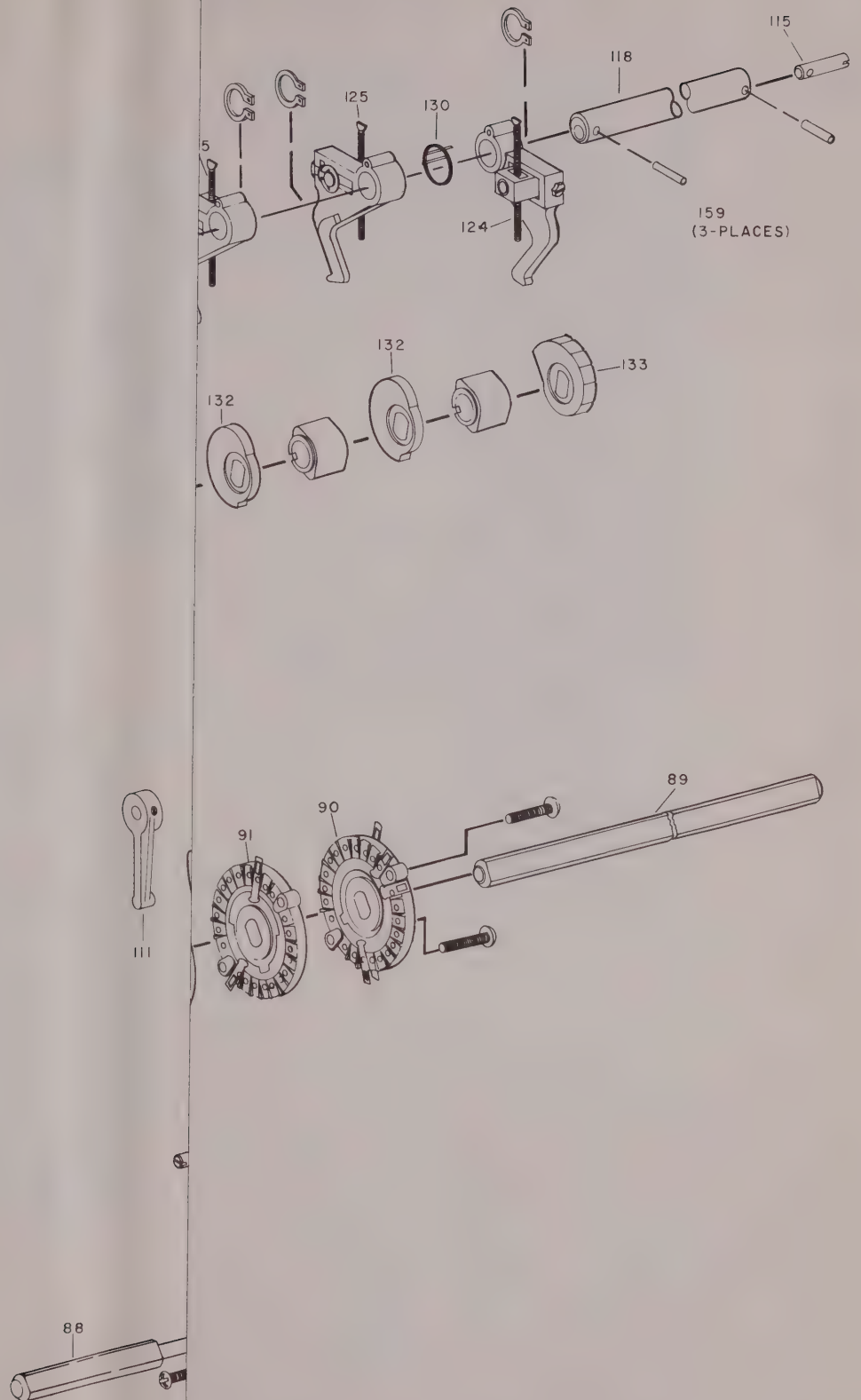
**Cessna DME 800 units 1401 and above and spares and/or replacements.

R-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
L-123	Choke, R-F, 4.7uh, 10%	019-2055-24
L-124	Choke, Molded, .09uh, 10%	019-2017-00
L-127A, B & C	Multiple Receiver R-F Inductor	047-1289-00
L-128	Choke, R-F, .12uh, 10%	019-2055-05
L-129	Choke, R-F, .12uh, 10%	019-2055-05
L-131	Inductor, Final Plate (5893 Tube)	047-1130-00
L-132	Coil, I-F, (63 mc Preamplifier Grid)	019-8018-00
L-133	Coil, I-F, (63 mc Preamplifier Plate)	019-8018-00
L-134	Choke, R-F, 4.7uh, 10%	019-2055-24
L-135	Choke, R-F, .12uh, 10%	019-2055-05
L-136	Tripler Plate Tank	250-1056-01
	Mica Insulator	019-0026-00
L-141	Choke, R-F, .12uh	019-2055-05
L-142	Choke, R-F, .12uh	019-2055-05
L-144	Choke, R-F, 10.0uh, 10%	019-2058-24
L-145	Choke, R-F, 2.0uh $\pm$ 10%	019-2062-00
L-146	Choke, R-F, 10.0uh, 10%	019-2058-24
L-147	Choke, R-F, 4.7uh, 10%	019-2058-20
M-101	Motor, mc Selector	148-5003-00
M-102	Motor, kc Selector	148-5003-00
N-101	Trap, 1/2 Frequency	250-1056-03
Q-101	Transistor, Silicon, LF Oscillator	007-0021-00
R-101	Resistor, Comp., 10K ohms, 1/4 watt	130-0103-25
R-102	Resistor, Comp., 47 ohms, 10%, 1/4 watt	130-0470-25
R-103	Resistor, Comp., 6.8K ohms, 10%, 1/2 watt	130-0682-35
R-104	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-105	Resistor, Comp., 4.7K ohms, 10%, 1/2 watt	130-0472-35
R-106	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-107	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-108	Resistor, Comp., 220K ohms, 10%, 1/4 watt	130-0224-25
R-109	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-111	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-112	Resistor, Comp., 4.7K ohms 10%, 1/4 watt	130-0472-25
R-113	Resistor, Comp., 1K ohms, 10%, 1/2 watt	130-0102-35
R-114	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-115	Resistor, W/W, 1K ohms, 10%, 3 watt	132-0016-00
R-116	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-117	Resistor, Comp., 27K ohms, 10%, 1/4 watt	130-0273-25
R-118	Resistor, Comp., 27K ohms, 10%, 1/4 watt	130-0273-25
R-119	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-120	Resistor, Comp., 100 ohms, 10%, 1/2 watt	130-0101-35
R-121	Resistor, Comp., 10 ohms, 10%, 1/4 watt	130-0100-25
R-122	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-123	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-124	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-125	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-126	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-127	Resistor, Comp., 220 ohms, 10%, 1/4 watt	130-0221-25
R-128	Resistor, Comp., 27K ohms, 10%, 1/4 watt	130-0273-25
R-129	Resistor, Comp., 10 ohms, 10%, 1/4 watt	130-0100-25
R-131	Resistor, W/W, 180 ohms, 10%, 2 watt	132-5001-00
R-132	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-133	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-134	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-135	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25

R-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
S-101	Switch, Wafer, #1	031-0053-00
S-102	Switch, Wafer, #2	031-0053-01
S-103	Switch, Wafer, #3	031-0053-02
S-104	Switch, Wafer, #4	031-0053-03
S-105	Switch, Wafer, #5	031-0053-04
TP-104	Test Point, Orange, (Doubler Grid)	010-0002-00
TP-105	Test Point, Orange, (Tripler Grid)	010-0002-00
TP-106	Test Point, Orange, (Final Cathode)	010-0002-00
TP-107	Test Point, Black, (Crystal Current)	010-0002-01
TP-108	Test Point, Black, (Sync)	010-0002-01
V-101	Electron Tube, 5893	021-0022-00
V-102	Electron Tube, 6CW4	021-0012-00
V-103	Electron Tube, 6939	021-0021-00
V-104	Electron Tube, 8106	021-0016-00
V-105	Electron Tube, SPECIAL	021-0020-00
V-106	Electron Tube, 6EA8	021-0013-00
Y-101	Crystal, Quartz, SPECIAL, 66.8017 mc	041-8668-01
Y-102	67.6350 mc	041-8676-35
Y-103	68.4683 mc	041-8684-68
Y-104	69.3017 mc	041-8693-01
Y-105	70.1347 mc	041-8701-34
Y-106	70.9683 mc	041-8709-68
Y-107	71.8017 mc	041-8718-01
Y-108	72.6350 mc	041-8726-35
Y-109	73.4683 mc	041-8734-68
Y-110	74.3017 mc	041-8743-01
Y-111	75.1347 mc	041-8751-34
Y-121	19.9483 mc	041-8199-48
Y-122	20.0316 mc	041-8200-31
Y-123	20.1149 mc	041-8201-14
Y-124	20.1983 mc	041-8201-98
Y-125	20.2816 mc	041-8202-81
Y-126	20.3649 mc	041-8203-64
Y-127	20.4483 mc	041-8204-48
Y-128	20.5316 mc	041-8205-31
Y-129	20.6149 mc	041-8206-14
Y-130	20.6983 mc	041-8206-98



F. Section Assembly

R-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
S-101	Switch, Wafer, #1	031-0053-00
S-102	Switch, Wafer, #2	031-0053-01
S-103	Switch, Wafer, #3	031-0053-02
S-104	Switch, Wafer, #4	031-0053-03
S-105	Switch, Wafer, #5	031-0053-04
TP-104	Test Point, Orange, (Doubler Grid)	010-0002-00
TP-105	Test Point, Orange, (Tripler Grid)	010-0002-00
TP-106	Test Point, Orange, (Final Cathode)	010-0002-00
TP-107	Test Point, Black, (Crystal Current)	010-0002-01
TP-108	Test Point, Black, (Sync)	010-0002-01
V-101	Electron Tube, 5893	021-0022-00
V-102	Electron Tube, 6CW4	021-0012-00
V-103	Electron Tube, 6939	021-0021-00
V-104	Electron Tube, 8106	021-0016-00
V-105	Electron Tube, SPECIAL	021-0020-00
V-106	Electron Tube, 6EA8	021-0013-00
Y-101	Crystal, Quartz, SPECIAL, 66.8017 mc	041-8668-01
Y-102	67.6350 mc	041-8676-35
Y-103	68.4683 mc	041-8684-68
Y-104	69.3017 mc	041-8693-01
Y-105	70.1347 mc	041-8701-34
Y-106	70.9683 mc	041-8709-68
Y-107	71.8017 mc	041-8718-01
Y-108	72.6350 mc	041-8726-35
Y-109	73.4683 mc	041-8734-68
Y-110	74.3017 mc	041-8743-01
Y-111	75.1347 mc	041-8751-34
Y-121	19.9483 mc	041-8199-48
Y-122	20.0316 mc	041-8200-31
Y-123	20.1149 mc	041-8201-14
Y-124	20.1983 mc	041-8201-98
Y-125	20.2816 mc	041-8202-81
Y-126	20.3649 mc	041-8203-64
Y-127	20.4483 mc	041-8204-48
Y-128	20.5316 mc	041-8205-31
Y-129	20.6149 mc	041-8206-14
Y-130	20.6983 mc	041-8206-98

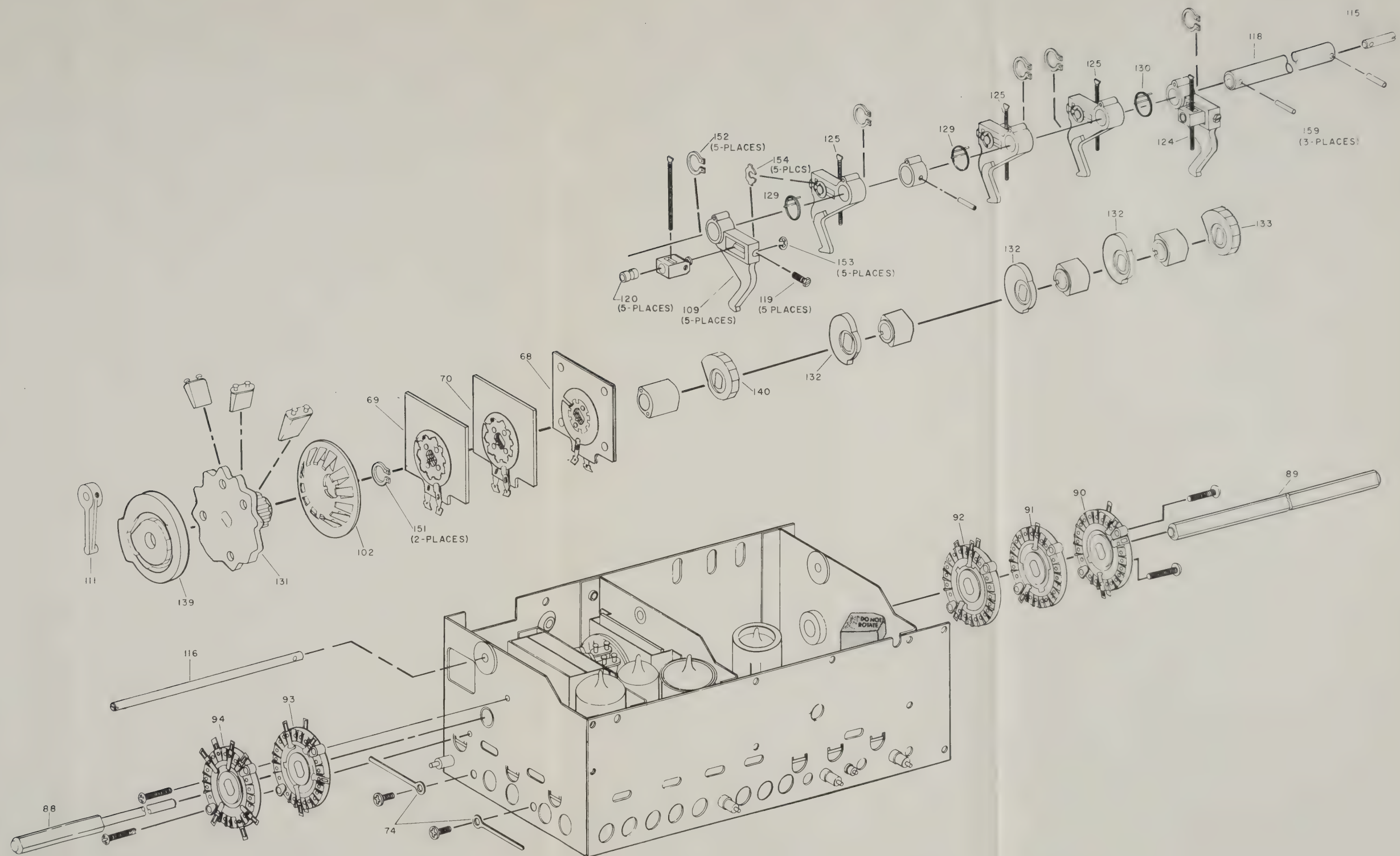


Figure 6-1. Cessna DME 800 Receiver/Transmitter R.F. Section Assembly

PULSE MODULATOR

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-201	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
C-202	Capacitor, Electrlytic, 4uf, -10 +50%, 200 WVDC	095-0001-00
C-205	Capacitor, Mylar, 22uf, 10%, 400 WVDC	105-0026-02
C-206	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-207	Capacitor, Mylar, .22uf, 10%, 400 WVDC	105-0026-02
C-208	Capacitor, Mylar, .22uf, 10%, 400 WVDC	105-0026-02
C-209	Capacitor, Mylar, .33uf, 10%, 400 WVDC	105-0026-03
C-210	Capacitor, Mylar, 3.3Kpf, 10%, 400 WVDC	105-0027-00
C-211	Capacitor, Mylar, .033uf, 10%, 200 WVDC	104-0018-68
C-213	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-214	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-215	Capacitor, Mylar, 1uf, 10%, 400 WVDC	105-0026-01
C-217	Capacitor, Mylar, 1uf, 10%, 400 WVDC	105-0026-01
C-218	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
C-219	Capacitor, Mylar, .1uf, 10%, 400 WVDC	105-0026-01
C-220	Capacitor, Mylar, .1uf, 10%, 400 WVDC	105-0026-01
C-222	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
CR-201	Diode, Silicon	007-6026-00
CR-202	Diode, Silicon	007-6028-00
CR-203	Diode, Germanium	007-6023-00
CR-204	Diode, Silicon	007-6028-00
CR-205	Diode, Silicon	007-6028-00
CR-206	Diode, Silicon	007-6026-00
DL-201	Delay Line	019-6003-01
L-201	Coil, Pulse Forming	019-6001-01
L-202	Coil, Pulse Separation, 1-2 mh	019-6004-01
L-203	Choke, R-F, 3.3uh, 10%	019-2049-00
L-204	Choke, R-F, 10uh, 10%	019-2058-24
L-205	Choke, R-F, 3.3uh, 10%	019-2049-00
L-206	Choke, R-F, 4.7uh, 10%	019-2048-20
L-207	Choke, R-F, 4.7uh, 10%	019-2048-20
L-208	Choke, R-F, 3.3uh, 10%	019-2049-00
R-201	Resistor, Comp., 47K ohms, 10%, 1/2 watt	130-0473-35
R-202	Resistor, W/W, 7K ohms, 10%, 3 watt	132-0018-00
R-203	Resistor, Comp., 6.8 ohms, 10%, 1/2 watt	130-0068-35
R-204	Resistor, Comp., 1K ohms, 10%, 1/2 watt	130-0102-35
R-205	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-206	Resistor, Comp., 10K ohms, 10%, 1 watt	130-0103-45
R-207	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-208	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-109	Resistor, Comp., 10K ohms, 10%, 1/2 watt	130-0103-35
R-110	Resistor, Comp., 10K ohms, 10%, 1/2 watt	130-0103-35
SCR-201	Silicon Control Rectifier	007-6027-00
SCR-202	Silicon Control Rectifier	007-6027-00
T-201	Driver Supply, Pulse Transformer	019-6005-01
T-202	Final Pulse Transformer	019-6006-01

R-F SECTION ASSEMBLY

REF. SYMBOL	DESCRIPTION	PART NUMBER
68	Var., Inductor, (Tripler Grid) L 117	031-0014-03
69	Var., Inductor, (H. F. OSC.) L 101	031-0014-04
70	Var., Inductor, (MXR & AMP) L 107	031-0014-05
74	Lug, Copper Tinned, #6, 1-1/4"	008-0005-01
88	Shaft, kc	031-0031-01
89	Shaft, mc	031-0032-01
90	Switch Wafer No. 1	031-0053-00
91	Switch Wafer No. 2	031-0053-01
92	Switch Wafer No. 3	031-0053-02
93	Switch Wafer No. 4	031-0053-03
94	Switch Wafer No. 5	031-0053-04
102	Retaining Ring, Crystal (2)	047-1121-00
109	Cam, Following Arm (5)	073-0009-00
111	Cam, Follower kc	073-0011-00
115	Shaft, Front Bearing	076-0006-00
116	Shaft, kc Tweek	076-0007-00
118	Support Shaft, Follower Arm	076-0010-01
119	Screw, Follower Adjust (5)	076-0013-01
120	Follower Pivots (5)	076-0015-00
124	Rod, Slug Connector (2)	076-0019-00
125	Rod, Slug Connector (3)	076-0019-01
129	Spring, Torsion, Following Arm Center	078-0002-00
130	Spring, Torsion, Following Arm Front	078-0003-00
131	Crystal Holder and Switch Indent (2)	088-0036-00
132	Cam, Preselector (3)	088-0038-01
133	Cam, Low Lift "A"	088-0039-00
139	Cam, kc	088-0042-00
140	Cam, Low Lift "C"	088-0043-01
151	Ret. Ring, Crystal Holder (2)	090-0019-01
152	Ret. Ring, Following Arm Shaft (5)	090-0019-03
153	Ret. Ring, Arm Adjust Screw (5)	090-0036-02
154	Ret. Ring, Bowed Arm Adjust (5)	090-0040-00
159	Roll Pin, 1/16 x 3/8 (3)	090-0052-00

PULSE MODULATOR

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-201	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
C-202	Capacitor, Electrylic, 4uf, -10 +50%, 200 WVDC	095-0001-00
C-205	Capacitor, Mylar, 22uf, 10%, 400 WVDC	105-0026-02
C-206	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-207	Capacitor, Mylar, .22uf, 10%, 400 WVDC	105-0026-02
C-208	Capacitor, Mylar, .22uf, 10%, 400 WVDC	105-0026-02
C-209	Capacitor, Mylar, .33uf, 10%, 400 WVDC	105-0026-03
C-210	Capacitor, Mylar, 3.3Kpf, 10%, 400 WVDC	105-0027-00
C-211	Capacitor, Mylar, .033uf, 10%, 200 WVDC	104-0018-68
C-213	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-214	Capacitor, Mylar, .47uf, 10%, 300 WVDC	105-0029-00
C-215	Capacitor, Mylar, 1uf, 10%, 400 WVDC	105-0026-01
C-217	Capacitor, Mylar, 1uf, 10%, 400 WVDC	105-0026-01
C-218	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
C-219	Capacitor, Mylar, .1uf, 10%, 400 WVDC	105-0026-01
C-220	Capacitor, Mylar, .1uf, 10%, 400 WVDC	105-0026-01
C-222	Capacitor, Mylar, .047uf, 10%, 400 WVDC	105-0026-00
CR-201	Diode, Silicon	007-6026-00
CR-202	Diode, Silicon	007-6028-00
CR-203	Diode, Germanium	007-6023-00
CR-204	Diode, Silicon	007-6028-00
CR-205	Diode, Silicon	007-6028-00
CR-206	Diode, Silicon	007-6026-00
DL-201	Delay Line	019-6003-01
L-201	Coil, Pulse Forming	019-6001-01
L-202	Coil, Pulse Separation, 1-2 mh	019-6004-01
L-203	Choke, R-F, 3.3uh, 10%	019-2049-00
L-204	Choke, R-F, 10uh, 10%	019-2058-24
L-205	Choke, R-F, 3.3uh, 10%	019-2049-00
L-206	Choke, R-F, 4.7uh, 10%	019-2048-20
L-207	Choke, R-F, 4.7uh, 10%	019-2048-20
L-208	Choke, R-F, 3.3uh, 10%	019-2049-00
R-201	Resistor, Comp., 47K ohms, 10%, 1/2 watt	130-0473-35
R-202	Resistor, W/W, 7K ohms, 10%, 3 watt	132-0018-00
R-203	Resistor, Comp., 6.8 ohms, 10%, 1/2 watt	130-0068-35
R-204	Resistor, Comp., 1K ohms, 10%, 1/2 watt	130-0102-35
R-205	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-206	Resistor, Comp., 10K ohms, 10%, 1 watt	130-0103-45
R-207	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-208	Resistor, Comp., 470 ohms, 10%, 1/2 watt	130-0471-35
R-109	Resistor, Comp., 10K ohms, 10%, 1/2 watt	130-0103-35
R-110	Resistor, Comp., 10K ohms, 10%, 1/2 watt	130-0103-35
SCR-201	Silicon Control Rectifier	007-6027-00
SCR-202	Silicon Control Rectifier	007-6027-00
T-201	Driver Supply, Pulse Transformer	019-6005-01
T-202	Final Pulse Transformer	019-6006-01

I-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-301	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-302	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-303	Capacitor, Ceramic, 1Kpf, +80-20%, 400 WVDC	113-5102-00
C-304	Capacitor, Ceramic, 10Kpf, 5%, 400 WVDC, N150	113-3100-00
C-305	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-306	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5102-01
C-307	Capacitor, Ceramic, 10pf, 5%, 400 WVDC, N150	113-3100-00
C-308	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-309	Capacitor, Mica, 150pf, 5%, 500 WVDC	104-0002-06
C-310	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-311	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-312	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-313	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-314	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-315	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-316	Capacitor, Mica, 150pf, 5%, 500 WVDC	104-0002-06
C-317	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-318	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-319	Capacitor, Mica, 150pf, 5%, 500 WVDC	104-0002-06
C-320	Capacitor, Ceramic, 2.2Kpf, 20%, 500 WVDC, Z5U	114-7222-00
C-321	Capacitor, Mylar, .022uf, 10%, 200 WVDC	105-0018-62
C-323	Capacitor, Mylar, .01uf, 10%, 25 WVDC	105-0024-03
C-324	Capacitor, Tantalum, .22uf, 20%, 35 WVDC	096-1013-00
C-325	Capacitor, Mylar, .047uf, 10%, 200 WVDC	105-0018-74
C-326	Capacitor, Mica, 150pf, 5%, 500 WVDC	104-0002-06
C-327	Capacitor, Tantalum, 0.1uf, 10%, 35 WVDC	096-1008-00
C-328	Capacitor, Mylar, .01uf, 10%, 200 WVDC	105-0018-50
C-329	Capacitor, Tantalum, 0.1uf, 10%, 35 WVDC	096-1008-00
C-331	Capacitor, Tantalum, 0.1uf, 20%, 35 WVDC	096-1008-00
C-334	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-335	Capacitor, Ceramic, 470pf, 20%, 400 WVDC, X5F	113-7471-00
C-336	Capacitor, Ceramic, 22pf, 5%, 400 WVDC, N150	113-3220-00
C-337	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-339	Capacitor, Ceramic, 220pf, 10%, 400 WVDC, X5F	113-5221-01
C-340	Capacitor, Ceramic, 12pf, 5%, 400 WVDC, N150	113-3120-00
C-341	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C342	Capacitor, Tantalum, 0.1uf, 10%, 35 WVDC	096-1008-00
CR-301	Diode, Silicon	007-6016-00
CR-302	Diode, Silicon	007-6029-00
DL-301	Delay Line, 12u Sec.	019-6003-01
L-301	Choke, R-F, 4.7uh	019-2055-24
L-302	Choke, R-F, 39uh	019-2058-34
L-303	Choke, R-F, .68uh	019-2055-14
L-305	Choke, R-F, 39uh	019-2058-34
L-306	Choke, R-F, 39uh	019-2058-34
L-307	Choke, R-F, 30uh	019-2058-34
L-308	Choke, 5mh, 10%	019-2048-00
L-310	Choke, R-F, .32uh, 5%	019-2057-05
L-311	Coil, I-F	019-2071-00
Q-301	Transistor, Silicon	007-0053-00
Q-302	Transistor, Silicon	007-0021-00
Q-303	Transistor, Silicon	007-0021-00
Q-304	Transistor, Silicon	007-0021-00
Q-305	Transistor, Silicon	007-0021-00
Q-306	Transistor, Silicon	007-0021-00
Q-307	Transistor, Germanium	007-0023-00
Q-308	Transistor, Silicon	007-0026-02
Q-309	Transistor, Silicon	007-0026-02
Q-310	Transistor, Germanium	007-0023-00

I-F SECTION

REF. SYMBOL	DESCRIPTION	PART NUMBER
Q-311	Transistor, Silicon	007-0031-00
Q-312	Transistor, Silicon	007-0033-00
Q-313	Transistor, Silicon	007-0026-02
R-301	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-302	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-304	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-305	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-306	Resistor, Comp., 220 ohms, 10%, 1/4 watt	130-0221-25
R-307	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-308	Resistor, Comp., 8.2K ohms, 10%, 1/4 watt	130-0822-25
R-309	Resistor, Comp., 12K ohms, 10%, 1/4 watt	130-0123-25
R-310	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-313	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-314	Resistor, Comp., 120 ohms, 10%, 1/4 watt	130-0121-25
R-315	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-316	Resistor, Comp., 12K ohms, 10%, 1/4 watt	130-0123-25
R-319	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-320	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-324	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-325	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-326	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-328	Resistor, Comp., 8.2K ohms, 10%, 1/4 watt	130-0822-25
R-329	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-330	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-331	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-333	Resistor, Comp., 8.2K ohms, 10%, 1/4 watt	130-0822-25
R-335	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-336	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-337	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-338	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-339	Resistor, Comp., 33K ohms, 10%, 1/4 watt	130-0333-25
R-340	Resistor, Comp., 220 ohms, 10%, 1/4 watt	130-0221-25
R-341	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-342	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-343	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
*R-344	Resistor, Comp., 18K ohms, 10%, 1/4 watt	130-0183-25
**	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-345	Resistor, Comp., 820 ohms, 10%, 1/4 watt	130-0821-25
R-346	Resistor, Variable, 1K ohms, 5%, 1 watt	133-0027-00
R-348	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
T-301	Coil, I-F, (63 mc)	019-8015-00
T-302	Coil, I-F, (8.5 mc)	019-8016-00
T-304	Coil, I-F, (8.5 mc)	019-8016-00
T-305	Coil, I-F, (8.5 mc)	019-8016-00
T-306	Coil, I-F, (8.5 mc)	019-8017-00
TR-301	Thermistor, 200 ohms, 10% with 25°C	134-1003-00
Y-301	Crystal, Quartz 71.4700 mc	045-1002-00

*Cessna DME 800 units 1394 and above.

**Cessna DME 800 units 1395 and below and spare and/or replacements.

FRAME COMPONENTS

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-419	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-420	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-421	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-422	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-423	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-424	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-425	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-426	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-427	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-428	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-429	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-430	Capacitor, Feed Thru, 1Kpf, 20%, 500 WVDC	106-0006-05
C-431	Capacitor, Tantalum, 68uf, 20%, 20 WVDC	096-1030-07
C-432	Capacitor, Tantalum, 10uf, 20%, 35 WVDC	096-1030-10
C-433	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-434	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-435	Capacitor, Ceramic, .01uf, +80-20%, 50 WVDC	113-6103-00
C-436	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-437	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-438	Capacitor, Tantalum, 10.0uf, 10%, 20 WVDC	096-1030-05
J-401	Connector, 32 Pin	030-2058-00
J-402	Connector, 23 Pin	030-2064-00
J-403	Connector, Co-Ax	030-0043-00
J-404	Connector, Co-Ax Receptacle	030-0037-00
J-405	Connector, Printed Circuit Board Receptacle	030-2059-00
J-406	Connector, Printed Circuit Board Receptacle	030-2059-00
J-407	Connector, Printed Circuit Board Receptacle	030-2059-00
J-408	Connector, Printed Circuit Board Receptacle	030-2059-00
J-409	Connector, Printed Circuit Board Receptacle	030-2059-00
J-410	Connector, Printed Circuit Board Receptacle	030-2059-00
J-411	Connector, Co-Ax	030-0038-00
L-405	Coil, Molded, 100uh, 5%	019-2065-00
L-406	Coil, Molded, 100uh, 5%	019-2065-00
L-407	Coil, Molded, 100uh, 5%	019-2065-00
P-411	Connector, Co-Ax	030-0039-00
R-401	Resistor, Variable, 2.5K ohms, Audio Output Adjust	133-0032-00
R-402	Resistor, Variable, 220 ohms, 10%, 1 watt	130-0221-45

INITIATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-501	Capacitor, Tantalum, 10uf, 10%, 20 WVDC	096-1030-05
C-502	Capacitor, Tantalum, 0.22uf, 10%, 35 WVDC	096-1021-00
C-503	Capacitor, Tantalum, 0.22uf, 10%, 35 WVDC	096-1021-00
C-504	Capacitor, Ceramic, 390pf, 10%, 400 WVDC, X5F	113-5391-00
C-505	Capacitor, Ceramic, 120pf, 5%, 400 WVDC, X5F	113-3121-00
C-506	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
C-507	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-508	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-509	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-511	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-512	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
C-513	Capacitor, Tantalum, 10uf, 10%, 20 WVDC	096-1030-05
C-514	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
C-515	Capacitor, Polycarbonate, 3.3Kpf, 5%, 50 WVDC	108-5001-00
C-516	Capacitor, Ceramic, 33pf, 5%, 400 WVDC, N150	113-3330-00
C-517	Capacitor, Tantalum, 0.1uf, 10%, 35 WVDC	096-1008-00
C-518	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-519	Capacitor, Tantalum, 10uf, 10%, 20 WVDC	096-1030-05
C-521	Capacitor, Mylar, 5.6Kpf, 10%, 200 WVDC	105-0018-41
C-522	Capacitor, Tantalum, .1uf, 10%, 15 WVDC	096-1020-00
C-523	Capacitor, Tantalum, .1uf, 10%, 15 WVDC	096-1020-00
C-524	Capacitor, Tantalum, 47uf, 10%, 15 WVDC	096-1030-06
C-525	Capacitor, Tantalum, 2.2uf, 10%, 15 WVDC	096-1030-03
C-526	Capacitor, Tantalum, 10uf, 10%, 20 WVDC	096-1030-05
C-527	Capacitor, Tantalum, 2.2uf, 10%, 15 WVDC	096-1030-03
C-528	Capacitor, Tantalum, 1.0uf, 20%, 20 WVDC	096-1030-01
C-529	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-531	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
CR-501	Diode, Zener, 12V, 20%	007-5008-00
CR-502	Diode, Silicon	007-6029-00
CR-503	Diode, Germanium	007-6023-00
CR-504	Diode, Germanium	007-6023-00
CR-505	Diode, Silicon	007-6016-00
CR-506	Diode, Silicon	007-6016-00
CR-507	Diode, Germanium	007-6023-00
CR-508	Diode, Silicon	007-6029-00
CR-509	Diode, Germanium	007-6023-00
CR-510	Diode, Silicon	007-6029-00
CR-511	Diode, Silicon	007-6029-00
CR-512	Diode, Silicon	007-6029-00
CR-513	Diode, Silicon	007-6029-00
CR-514	Diode, Silicon	007-6029-00
CR-515	Diode, Silicon	007-6029-00
CR-516	Diode, Silicon	007-6029-00
CR-517	Diode, Silicon	007-6029-00
CR-518	Diode, Silicon	007-6029-00
CR-519	Diode, Germanium	007-6023-00
CR-520	Diode, Silicon	007-6029-00
CR-521	Diode, Silicon	007-6029-00
CR-522	Diode, Silicon	007-6029-00
CR-523	Diode, Silicon	007-6029-00
L-501	Coil, Molded, 100uh, 5%	019-2065-00
Q-501	Transistor, silicon	007-0035-00
Q-502	Transistor, Silicon	007-0043-00
Q-503	Transistor, Silicon	007-0034-00
Q-504	Transistor, Silicon	007-0034-00
Q-505	Transistor, Silicon	007-0026-01
Q-506	Transistor, Silicon	007-0026-01
Q-507	Transistor, Silicon	007-0026-01
Q-508	Transistor, Silicon	007-0046-00
Q-509	Transistor, Silicon	007-0046-00

INITIATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
Q-510	Transistor, Silicon	007-0046-00
Q-511	Transistor, Silicon	007-0046-00
Q-512	Transistor, Silicon	007-0035-00
Q-513	Transistor, Silicon	007-0034-00
Q-514	Transistor, Silicon	007-0034-00
Q-515	Transistor, Silicon	007-0043-00
Q-516	Transistor, Silicon	007-0034-00
Q-517	Transistor, Silicon	007-0034-00
Q-518	Transistor, Silicon	007-0043-00
Q-519	Transistor, Silicon	007-0034-00
Q-520	Transistor, Silicon	007-0034-00
Q-521	Transistor, Silicon	007-0026-01
Q-522	Transistor, Silicon	007-0026-01
Q-523	Transistor, Silicon	007-0026-01
Q-524	Transistor, Silicon	007-0043-00
Q-525	Transistor, Silicon	007-0034-00
Q-526	Transistor, Silicon	007-0034-00
R-501	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-502	Resistor, Comp., 6.8K ohms, 10%, 1/4 watt	130-0682-25
R-503	Resistor, Comp., 10 ohms, 10%, 1/4 watt	130-0100-25
R-504	Resistor, Precision, 681K, 1.0%, 1/4 watt	136-6813-72
R-505	Resistor, Precision, 121K, 1.0%, 1/4 watt	136-1213-72
R-506	Resistor, Comp., 2.2K, 10%, 1/4 watt	130-0222-25
R-507	Resistor, Comp., 150 ohms, 10%, 1/4 watt	130-0151-25
R-508	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-509	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-511	Resistor, Variable, (P.R.F. Adj.), 1K ohms, 5%, 1 watt	133-0027-00
R-512	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-513	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-514	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-515	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-516	Resistor, Comp., 56K ohms, 10%, 1/4 watt	130-0563-25
R-517	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-518	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-519	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-521	Resistor, Comp., 5.6K 10%, 1/4 watt	130-0562-25
R-522	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-523	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-524	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-525	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-526	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-527	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-528	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-529	Resistor, Comp., 2.0K ohms, 5%, 1/4 watt	130-0202-23
R-531	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-532	Resistor, Comp., 3.0K ohms, 5%, 1/4 watt	130-0302-23
R-533	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0302-23
R-534	Resistor, Precision, 22.1K ohms, 1.0%, 1/4 watt	136-2212-72
R-535	Resistor, Variable, Zero Mile Adj., 10K ohms, 5%, 1 watt	133-0028-00
R-536	Resistor, Comp., 3.0K ohms, 5%, 1/4 watt	130-0302-23
R-537	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-538	Resistor, Comp., 3.0K ohms, 5%, 1/4 watt	130-0302-23
R-539	Resistor, Comp., 6.8K, 10%, 1/4 watt	130-0682-25
R-541	Resistor, Comp., 220 ohms, 10%, 1/4 watt	130-0221-25
R-542	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-543	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-544	Resistor, Comp., 56K, 10%, 1/4 watt	130-0563-25
R-545	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-546	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-547	Resistor, Comp., 27K ohms, 10%, 1/4 watt	130-0273-25
R-548	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-549	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25

INITIATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-551	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-552	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-553	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-554	Resistor, Comp., 330 ohms, 10%, 1/4 watt	130-0331-25
R-555	Resistor, Comp., 330K ohms, 10%, 1/4 watt	130-0334-25
R-556	Resistor, Comp., 47 ohms, 10%, 1/4 watt	130-0470-25
R-557	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-558	Resistor, Comp., 56K ohms, 10%, 1/4 watt	130-0563-25
R-559	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-561	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0222-25
R-562	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-563	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-564	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-565	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-566	Resistor, Comp., 820K ohms, 10%, 1/4 watt	130-0824-25
R-567	Resistor, Comp., 82K ohms, 10%, 1/4 watt	130-0823-25
R-568	Resistor, Comp., 330 ohms, 10%, 1/4 watt	130-0331-25
R-569	Resistor, Comp., 47 ohms, 10T, 1/4 watt	130-0470-25
R-571	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-572	Resistor, Comp., 33K ohms, 10%, 1/4 watt	130-0333-25
R-573	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-574	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-575	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-576	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-577	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-578	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-579	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-581	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-583	Resistor, Comp., 1.2K ohms, 10%, 1/4 watt	130-0122-25
R-584	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0183-25
R-585	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-586	Resistor, Comp., 330 ohms, 10%, 1/4 watt	130-0331-25
R-587	Resistor, Comp., 150 ohms, 10%, 1/4 watt	130-0151-25
R-588	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-589	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-591	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-592	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-593	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-594	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-595	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
Y-501	Crystal, Quartz 1.6176 mc	045-1004-00

GATE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-601	Capacitor, Mylar, 820pf, 10%, 200 WVDC	105-0018-11
C-602	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-603	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-604	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-605	Capacitor, Tantalum, 1.0uf, 20%, 20 WVDC	096-1030-01
C-606	Capacitor, Ceramic, 33pf, 5%, 400 WVDC, N150	113-3330-00
C-607	Capacitor, Mylar, 820pf, 10%, 200 WVDC	105-0018-11
C-608	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-611	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-612	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-613	Capacitor, Tantalum, 3.3uf, 10%, 15 WVDC	096-1030-12
C-614	Capacitor, Tantalum, 4.7uf, 20%, 20 WVDC	096-1030-11
C-615	Capacitor, Tantalum, 4.7uf, 20%, 20 WVDC	096-1030-11
C-616	Capacitor, Tantalum, 3.3uf, 10%, 15 WVDC	096-1030-12
C-617	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-618	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
C-619	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-621	Capacitor, Mylar, 3.3Kpf, 10%, 200 WVDC	105-0018-32
C-622	Capacitor, Mylar, 2.2uf, 10%, 15 WVDC	096-1030-03
C-623	Tantalum, .22uf, 10%, 35 WVDC	096-1021-00
C-624	Capacitor, Mylar, 2.2uf, 10%, 15 WVDC	096-1030-03
C-629	Capacitor, Ceramic, 100pf, 10%, 400 WVDC, X5F	113-5101-01
CR-601	Diode, Germanium	007-6023-00
CR-602	Diode, Germanium	007-6023-00
CR-603	Diode, Germanium	007-6023-00
CR-604	Diode, Germanium	007-6023-00
CR-605	Diode, Silicon	007-6016-00
CR-606	Diode, Germanium	007-6023-00
CR-607	Diode, Germanium	007-6023-00
CR-608	Diode, Germanium	007-6023-00
CR-609	Diode, Silicon	007-6016-00
CR-610	Diode, Silicon	007-6029-00
CR-611	Diode, Silicon	007-6029-00
CR-612	Diode, Silicon	007-6029-00
CR-613	Diode, Silicon	007-6029-00
CR-614	Diode, Silicon	007-6029-00
CR-615	Diode, Silicon	007-6016-00
CR-616	Diode, Germanium	007-6023-00
CR-617	Diode, Silicon	007-6029-00
CR-618	Diode, Silicon	007-6029-00
CR-619	Diode, Silicon	007-6029-00
CR-620	Diode, Silicon	007-6029-00
CR-621	Diode, Silicon	007-6029-00
CR-622	Diode, Germanium	007-6023-00
CR-623	Diode, Germanium	007-6023-00
CR-624	Diode, Germanium	007-6023-00
CR-625	Diode, Germanium	007-6023-00
CR-626	Diode, Germanium	007-6023-00
CR-627	Diode, Germanium	007-6023-00
CR-628	Diode, Germanium	007-6023-00
CR-629	Diode, Silicon	007-6016-00
CR-630	Diode, Silicon	007-6029-00
CR-631	Diode, Germanium	007-6023-00
Q-601	Transistor, Silicon	007-0046-00
Q-602	Transistor, Silicon	007-0046-00
Q-603	Transistor, Silicon	007-0046-00
Q-604	Transistor, Silicon	007-0046-00
Q-605	Transistor, Silicon	007-0046-00
Q-606	Transistor, Silicon	007-0046-00
Q-607	Transistor, Silicon	007-0046-00
Q-608	Transistor, Silicon	007-0046-00
Q-609	Transistor, Silicon	007-0043-00

GATE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
Q-610	Transistor, Silicon	007-0043-00
Q-611	Transistor, Silicon	007-0046-00
Q-612	Transistor, Silicon	007-0046-00
Q-613	Transistor, Silicon	007-0034-00
Q-614	Transistor, Silicon	007-0034-00
Q-615	Transistor, Silicon	007-0034-00
Q-616	Transistor, Silicon	007-0034-00
Q-617	Transistor, Silicon	007-0034-00
Q-618	Transistor, Silicon	007-0034-00
Q-619	Transistor, Silicon	007-0026-01
Q-620	Transistor, Silicon	007-0026-01
Q-621	Transistor, Silicon	007-0026-01
Q-622	Transistor, Silicon	007-0026-01
R-601	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-602	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-603	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-604	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-605	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-606	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-607	Resistor, Comp., 10K ohms, 10T, 1/4 watt	130-0103-25
R-608	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0103-25
R-609	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-611	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-612	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-613	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-614	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-615	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-616	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-617	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-618	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-619	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-621	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-622	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-623	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-624	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-625	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-626	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-627	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-628	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-629	Resistor, Comp., 2.0K ohms, 5%, 1/4 watt	130-0202-23
R-630	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-631	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-633	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-634	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-635	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-636	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-637	Resistor, Comp., 330K ohms, 10%, 1/4 watt	130-0334-25
R-638	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-639	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-641	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-642	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-643	Resistor, Comp., 39 ohms, 10%, 1/4 watt	130-0390-25
R-644	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-645	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-646	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-647	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-648	Resistor, Comp., 39 ohms, 10%, 1/4 watt	130-0390-25
R-649	Resistor, Comp., 330K ohms, 10%, 1/4 watt	130-0334-25
R-651	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-652	Resistor, Comp., 3.3K ohms, 10%, 1/4 watt	130-0332-25
R-653	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-654	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25

GATE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-655	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-656	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-657	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-658	Resistor, Comp., 2.0K ohms, 5%, 1/4 watt	130-0202-23
R-659	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-661	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-662	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-663	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-664	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-665	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-666	Resistor, Comp., 1.2K ohms, 10%, 1/4 watt	130-0122-25
R-667	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-668	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-669	Resistor, Comp., 1.2K ohms, 10%, 1/4 watt	130-0122-25
R-671	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-672	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-673	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-674	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-675	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-676	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-677	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-678	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-679	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-681	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-682	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-683	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-684	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-685	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-686	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-687	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-688	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-689	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-691	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-692	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-693	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-694	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-695	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-696	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-697	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-698	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-699	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-701	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-702	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-703	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-704	Resistor, Comp., 6.8K ohms, 10%, 1/4 watt	130-0682-25
R-705	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-706	Resistor, Comp., 390 ohms, 10%, 1/4 watt	130-0391-25
R-707	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-708	Resistor, Comp., 56K ohms, 10%, 1/4 watt	130-0563-25
R-709	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-711	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-712	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-713	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-714	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-715	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0680-25

OPERATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-801	Capacitor, Ceramic, 220pf, 10%, 400 WVDC, X5F	113-5221-01
C-802	Capacitor, Mylar, 1Kpf, 10%, 200 V	105-0018-14
C-803	Capacitor, Ceramic, 4.7pf, 5%, 400 WVDC, N150	113-3047-00
C-804	Capacitor, Mylar, 1Kpf, 10%, 200 V	105-0018-14
C-805	Capacitor, Ceramic, 4.7pf, 5%, 400 WVDC, N150	113-3047-00
C-806	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-807	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-808	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-809	Capacitor, Ceramic, 33pf, 5%, 400 WVDC, N150	113-3330-00
C-811	Capacitor, Ceramic, 330pf, 10%, 400 WVDC, X5F	113-5331-00
C-812	Capacitor, Ceramic, 330pf, 10%, 400 WVDC, X5F	113-5331-00
C-813	Capacitor, Ceramic, 330pf, 10%, 400 WVDC, X5F	113-5331-00
C-814	Capacitor, Ceramic, 330pf, 10%, 400 WVDC, X5F	113-5331-00
C-815	Capacitor, Ceramic, 330pf, 10%, 400 WVDC, X5F	113-5331-00
C-816	Capacitor, Ceramic, 68pf, 10%, 400 WVDC, X5F	113-5680-00
C-817	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-818	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-819	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-821	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-822	Capacitor, Polycarbonate, 4.7Kpf, 5%, 50 V	108-5002-00
C-823	Capacitor, Polycarbonate, 4.7Kpf, 5%, 50 V	108-5002-00
C-824	Capacitor, Polycarbonate, .01uf, 5%, 50 V	108-5003-00
C-825	Capacitor, Mylar, .047uf, 10%, 200 V	105-0018-74
C-826	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-827	Capacitor, Tantalum, 2.2uf, 10%, 15 WVDC	096-1030-03
C-828	Capacitor, Tantalum, 2.2uf, 10%, 15 WVDC	096-1030-03
C-829	Capacitor, Tantalum, 2.2uf, 10%, 15 WVDC	096-1030-03
C-831	Capacitor, Ceramic, 390pf, 10%, 400 WVDC, X5F	113-5391-00
C-832	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-833	Capacitor, Ceramic, 68pf, 10%, 400 WVDC, X5F	113-3180-00
C-834	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-835	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-836	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-837	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-838	Capacitor, Tantalum, 1.0uf, 20%, 20 WVDC	096-1030-01
C-839	Capacitor, Ceramic, 68pf, 10%, 400 WVDC, X5F	113-5680-00
CR-801	Diode, Germanium	007-6023-00
CR-802	Diode, Germanium	007-6023-00
CR-803	Diode, Germanium	007-6023-00
CR-804	Diode, Germanium	007-6023-00
CR-805	Diode, Silicon	007-6016-00
CR-806	Diode, Germanium	007-6023-00
CR-807	Diode, Germanium	007-6023-00
CR-808	Diode, Germanium	007-6023-00
CR-809	Diode, Germanium	007-6023-00
CR-810	Diode, Germanium	007-6023-00
CR-811	Diode, Germanium	007-6023-00
CR-812	Diode, Germanium	007-6023-00
CR-813	Diode, Germanium	007-6023-00
CR-814	Diode, Germanium	007-6023-00
CR-815	Diode, Germanium	007-6023-00
CR-816	Diode, Germanium	007-6023-00
CR-817	Diode, Silicon	007-6016-00
CR-818	Diode, Silicon	007-6016-00
CR-819	Diode, Silicon	007-6016-00
CR-820	Diode, Germanium	007-6023-00
CR-821	Diode, Germanium	007-6023-00
CR-822	Diode, Silicon	007-6016-00
CR-823	Diode, Silicon	007-6016-00
CR-824	Diode, Silicon	007-6029-00

OPERATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
CR-825	Diode, Silicon	007-6029-00
CR-826	Diode, Silicon	007-6016-00
CR-827	Diode, Germanium	007-6023-00
L-801	Coil, Molded, 100uh, 20%	019-2065-00
Q-801	Transistor, Silicon	007-0046-00
Q-802	Transistor, Silicon	007-0046-00
Q-803	Transistor, Silicon	007-0046-00
Q-804	Transistor, Silicon	007-0046-00
Q-805	Transistor, Silicon	007-0046-00
Q-806	Transistor, Silicon	007-0046-00
Q-807	Transistor, Silicon	007-0046-00
Q-808	Transistor, Silicon	007-0034-00
Q-809	Transistor, Silicon	007-0046-00
Q-810	Transistor, Silicon	007-0046-00
Q-811	Transistor, Silicon	007-0035-00
Q-812	Transistor, Silicon	007-0034-00
Q-813	Transistor, Silicon	007-0026-01
Q-814	Transistor, Silicon	007-0026-03
Q-815	Transistor, Silicon	007-0026-03
Q-816	Transistor, Silicon	007-0046-00
Q-817	Transistor, Silicon	007-0046-00
Q-818	Transistor, Silicon	007-0046-00
Q-819	Transistor, Silicon	007-0046-00
Q-820	Transistor, Silicon	007-0026-01
Q-821	Transistor, Silicon	007-0026-01
R-801	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-802	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-803	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-804	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-805	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-806	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-807	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-808	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-809	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-811	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-812	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-813	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-814	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-815	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-816	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-817	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-818	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-819	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-821	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-822	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-823	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-824	Resistor, Comp., 47 ohms, 10%, 1/4 watt	130-0470-25
R-825	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-826	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-827	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-828	Resistor, Comp., 820 ohms, 10%, 1/4 watt	130-0821-25
R-829	Resistor, Comp., 6.8K ohms, 10%, 1/4 watt	130-0682-25
R-831	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-832	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-833	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-834	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-835	Resistor, Comp., 6.8K ohms, 10%, 1/4 watt	130-0682-25
R-836	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-837	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-838	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-839	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-841	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25

OPERATION CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-842	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-843	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-844	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-845	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-846	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-847	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-848	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-849	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-851	Resistor, Comp., 13K ohms, 10%, 1/4 watt	130-0133-23
R-852	Resistor, Comp., 27K ohms, 5%, 1/4 watt	130-0273-23
R-853	Resistor, Comp., 27K ohms, 5%, 1/4 watt	130-0273-23
R-854	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-855	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-856	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-857	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-858	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-859	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-861	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-862	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-863	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-864	Resistor, Comp., 1.3K ohms, 5%, 1/4 watt	130-0132-23
R-865	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-866	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-867	Resistor, Comp., 10 ohms, 10%, 1/4 watt	130-0100-25
R-868	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-869	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-871	Resistor, Comp., 10 ohms, 10%, 1/4 watt	130-0100-25
R-872	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-873	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-874	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-875	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-876	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-877	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-878	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-879	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-881	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-882	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-883	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-884	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-885	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-886	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-887	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-888	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-889	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-891	Resistor, Comp., 15K ohms, 10%, 1/4 watt	130-0153-25
R-892	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-893	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-894	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-895	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
T-801	Transformer	019-5036-00

RANGE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-901	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-902	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-903	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-904	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-905	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-906	Capacitor, Ceramic, 150pf, 10%, 400 WVDC, X5F	113-5151-01
C-907	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-908	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-909	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-911	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-912	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-913	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-914	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-915	Capacitor, Ceramic, 18pf, 5%, 400 WVDC, N150	113-3180-00
C-916	Capacitor, Ceramic, 150pf, 10%, 400 WVDC, X5F	113-5151-01
C-917	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-918	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-919	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-921	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-922	Capacitor, Ceramic, 47pf, 5%, 400 WVDC, X5F	113-3470-00
C-923	Capacitor, Tantalum, 1.0uf, 20%, 20 WVDC	096-1030-01
C-924	Capacitor, Tantalum, 1.0uf, 20%, 20 WVDC	096-1030-01
CR-901	Diode, Silicon	007-6029-00
CR-902	Diode, Silicon	007-6029-00
CR-903	Diode, Silicon	007-6029-00
CR-904	Diode, Silicon	007-6029-00
CR-905	Diode, Silicon	007-6029-00
CR-906	Diode, Silicon	007-6029-00
CR-907	Diode, Silicon	007-6029-00
CR-908	Diode, Silicon	007-6029-00
CR-909	Diode, Silicon	007-6029-00
CR-910	Diode, Silicon	007-6029-00
CR-911	Diode, Germanium	007-6023-00
CR-912	Diode, Germanium	007-6023-00
CR-913	Diode, Germanium	007-6023-00
CR-914	Diode, Germanium	007-6023-00
CR-915	Diode, Germanium	007-6023-00
CR-916	Diode, Silicon	007-6016-00
CR-917	Diode, Silicon	007-6016-00
CR-918	Diode, Silicon	007-6016-00
CR-919	Diode, Silicon	007-6016-00
CR-920	Diode, Silicon	007-6016-00
CR-921	Diode, Silicon	007-6016-00
CR-922	Diode, Silicon	007-6016-00
CR-923	Diode, Silicon	007-6016-00
CR-924	Diode, Silicon	007-6016-00
CR-925	Diode, Silicon	007-6016-00
CR-926	Diode, Silicon	007-6016-00
CR-927	Diode, Silicon	007-6029-00
CR-928	Diode, Silicon	007-6029-00
CR-929	Diode, Silicon	007-6029-00
CR-930	Diode, Silicon	007-6029-00
CR-931	Diode, Germanium	007-6023-00
CR-932	Diode, Germanium	007-6023-00
CR-933	Diode, Germanium	007-6023-00
CR-934	Diode, Germanium	007-6023-00
CR-935	Diode, Germanium	007-6023-00
CR-936	Diode, Silicon	007-6016-00
CR-937	Diode, Silicon	007-6016-00
CR-938	Diode, Silicon	007-6016-00
CR-939	Diode, Silicon	007-6016-00
CR-940	Diode, Silicon	007-6016-00

RANGE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
Q-901	Transistor, Silicon	007-0026-01
Q-902	Transistor, Silicon	007-0026-01
Q-903	Transistor, Silicon	007-0026-01
Q-904	Transistor, Silicon	007-0026-01
Q-905	Transistor, Silicon	007-0026-01
Q-906	Transistor, Silicon	007-0026-01
Q-907	Transistor, Silicon	007-0026-01
Q-908	Transistor, Silicon	007-0026-01
Q-909	Transistor, Silicon	007-0026-01
Q-910	Transistor, Silicon	007-0026-01
Q-911	Transistor, Silicon	007-0026-01
Q-912	Transistor, Silicon	007-0026-01
Q-913	Transistor, Silicon	007-0026-01
Q-914	Transistor, Silicon	007-0026-01
Q-915	Transistor, Silicon	007-0026-01
Q-916	Transistor, Silicon	007-0046-00
Q-917	Transistor, Silicon	007-0046-00
Q-918	Transistor, Silicon	007-0046-00
Q-919	Transistor, Silicon	006-0046-00
Q-920	Transistor, Silicon	007-0046-00
Q-921	Transistor, Silicon	007-0046-00
Q-922	Transistor, Silicon	007-0046-00
Q-923	Transistor, Silicon	007-0046-00
Q-924	Transistor, Silicon	007-0046-00
Q-925	Transistor, Silicon	007-0026-01
Q-926	Transistor, Silicon	007-0026-01
Q-927	Transistor, Silicon	007-0026-01
Q-928	Transistor, Silicon	007-0026-01
Q-929	Transistor, Silicon	007-0046-00
Q-930	Transistor, Silicon	007-0046-00
Q-931	Transistor, Silicon	007-0046-00
Q-932	Transistor, Silicon	007-0046-00
Q-933	Transistor, Silicon	007-0046-00
R-901	Resistor, Comp., 1.5K ohms, 10%, 1/4 Watt	130-0152-25
R-902	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-903	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-904	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-905	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-906	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-907	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-908	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-909	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-911	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-912	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-913	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-914	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-915	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-916	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-917	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-918	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-919	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-921	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-922	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-923	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-924	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-925	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-926	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-927	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-928	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-929	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-931	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-932	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25

RANGE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-933	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-934	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-935	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-936	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-937	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-938	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-939	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-941	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-942	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-943	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-944	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-945	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-946	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-947	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-948	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-949	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-951	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-952	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-953	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-954	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-955	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-956	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-957	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-958	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-959	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-961	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-962	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-963	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-964	Resistor, Comp., 150 ohms, 10%, 1/4 watt	130-0151-25
R-965	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-966	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-967	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-968	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-969	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-971	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-972	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-973	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-974	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-975	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-976	Resistor, Comp., 5.6K ohms, 10%, 1/4 watt	130-0562-25
R-977	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-978	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-979	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-981	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-982	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-983	Resistor, Comp., 1.8K ohms, 10%, 1/4 watt	130-0182-25
R-984	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-985	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-986	Resistor, Comp., 1.2K ohms, 10%, 1/4 watt	130-0122-25
R-987	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-988	Resistor, Comp., 1.2K ohms, 10%, 1/4 watt	130-0122-25
R-989	Resistor, Comp., 1.5K ohms, 10%, 1/4 watt	130-0152-25
R-991	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-992	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
R-993	Resistor, Comp., 150 ohms, 10%, 1/4 watt	130-0151-25
R-994	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-995	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-996	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-997	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-998	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-999	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1001	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25

RANGE CIRCUIT BOARD

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-1002	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1003	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1004	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1005	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1006	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1007	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1008	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1009	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1011	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1012	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1013	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1014	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1015	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1016	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1017	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1018	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1019	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1021	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1022	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1023	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1024	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1025	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-1026	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1027	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-1028	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25

MOTOR CONTROL

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-1101	Capacitor, Tantalum, 2.2uf, 20%, 50 WVDC	096-1031-00
C-1102	Capacitor, Mylar, .01uf, 10%, 200 WVDC	105-0018-50
CR-1101	Diode, Germanium	007-6023-00
CR-1102	Diode, Germanium	007-6023-00
CR-1103	Diode, Silicon	007-6024-00
CR-1104	Diode, Silicon	007-6024-00
CR-1105	Diode, Silicon	007-6024-00
CR-1106	Diode, Silicon	007-6024-00
CR-1107	Diode, Silicon	007-6024-00
CR-1108	Diode, Silicon	007-6024-00
Q-1101	Transistor, Germanium	007-0040-00
Q-1102	Transistor, Germanium	007-0040-00
Q-1103	Transistor, Silicon	007-0026-03
Q-1104	Transistor, Silicon	007-0026-03
R-1101	Resistor, Comp., 2.2K ohms, 10%, 1/2 watt	130-0222-35
R-1102	Resistor, Comp., 1.5K ohms, 10%, 1/2 watt	130-0152-35
R-1103	Resistor, Comp., 1.5K ohms, 10%, 1/2 watt	130-0152-35
R-1105	Resistor, Comp., 33 ohms, 10%, 1/2 watt	130-0330-35
R-1106	Resistor, Comp., 33 ohms, 10%, 1/2 watt	130-0330-35

POWER SUPPLY

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-1201	Capacitor, Mylar, 0.1uf, 10%, 200 WVDC	105-0018-86
C-1202	Capacitor, Mylar, 0.1uf, 10%, 200 WVDC	105-0018-86
C-1203	Capacitor, Electrolytic, 100uf, -10 +75%, 70 WVDC	095-0004-00
C-1204	Capacitor, Feed Thru, .33uf $\pm$ 20%, 100 WVDC	106-0010-00
C-1205	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-1206	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-1207	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-1208	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
C-1209	Capacitor, Electrolytic, 16uf, -10 +75%, 200 WVDC	095-0005-00
C-1211	Capacitor, Tantalum, 15uf, 20%, 75 WVDC	096-1022-00
C-1213	Capacitor, Tantalum, 15uf, 20%, 75 WVDC	096-1022-00
C-1214	Capacitor, Electrolytic, 50uf, -10 +75%, 70 WVDC	095-0002-00
C-1215	Capacitor, Electrolytic, 100uf, -10 +75%, 40 WVDC	095-0003-00
C-1216	Capacitor, Tantalum, 22uf, 20%, 20 WVDC	096-1023-00
C-1217	Capacitor, Tantalum, 47uf, 20%, 35 WVDC	096-1024-00
CR-1201	Diode, Silicon	007-6024-00
CR-1202	Diode, Silicon	007-6024-00
CR-1203	Diode, Silicon	007-6026-00
CR-1204	Diode, Silicon	007-6026-00
CR-1205	Diode, Silicon	007-6026-00
CR-1206	Diode, Silicon	007-6026-00
CR-1207	Diode, Silicon	007-6025-00
CR-1208	Diode, Silicon	007-6025-00
CR-1209	Diode, Silicon	007-6025-00
CR-1211	Diode, Silicon	007-6025-00
CR-1212	Diode, Silicon	007-6024-00
CR-1213	Diode, Silicon	007-6024-00
CR-1214	Diode, Silicon	007-6025-00
CR-1215	Diode, Silicon	007-6025-00
CR-1216	Diode, Silicon	007-6024-00
CR-1217	Diode, Zener, 3.9V, 10%	007-5007-00
CR-1218	Diode, Zener, 6.8V, 20%	007-5006-00
F-1201	Fuse, 3 Amp (28V)	036-0008-00
or		
F-1201	Fuse, 6.25 Amp (14V)	036-0021-00
L-1201	Choke, Toroid, 50uh, 20%	019-2072-00
L-1202	Inductor, Hash Filter, 125uh	019-2041-00
L-1203	Choke, Toroid, 1.0mh, 20%	019-2068-00
L-1204	Choke, Toroid, 1.0mh, 20%	019-2068-00
Q-1201	Transistor, Germanium	007-0041-00
Q-1202	Transistor, Germanium	007-0041-00
Q-1203	Transistor, Germanium	007-0045-00
Q-1204	Transistor, Silicon	007-0042-00
Q-1205	Transistor, Silicon	007-0026-03
R-1201	Resistor, Comp., 270 ohms, 10%, 1 watt	130-0271-45
R-1202	Resistor, Comp., 68 ohms, 10%, 1/2 watt	130-0680-35
R-1203	Resistor, Comp., 10 ohms, 5%, 1 watt	130-0100-43
R-1204	Resistor, Comp., 2.2K ohms, 10%, 2 watt	130-0222-55
R-1205	Resistor, Comp., 2.2K ohms, 10%, 2 watt	130-0222-55
R-1206	Resistor, Comp., 10 ohms, 5%, 1 watt	130-0100-43
R-1207	Resistor, Comp., 68 ohms, 10%, 1/2 watt	130-0680-35
R-1208	Resistor, W/W, 1.5K ohms, 1%, 10 watt	132-0025-00
R-1209	Resistor, W/W, 500 ohms, 1%, 10 watt	132-0026-00
R-1211	Resistor, Comp., 270 ohms, 10%, 1/2 watt	130-0271-35
R-1212	Resistor, W/W, 30 ohms, 1%, 10 watt	132-0027-00
R-1213	Resistor, Comp., 68 ohms, 10%, 1/2 watt	130-0680-35
R-1214	Resistor, Comp., 2.7K ohms, 10%, 1/2 watt	130-0272-35
R-1215	Resistor, Comp., 1K ohms, 10%, 1/2 watt	130-0102-35
R-1216	Resistor, Comp., SELECTED VALUE, 0 to 2K ohms, 10%	
R-1217	Resistor, Comp., 1.5K ohms, 10%, 1/2 watt	130-0152-35
R-1218	Resistor, Comp., 1.2K ohms, 10%, 1/2 watt	130-0122-35
R-1219	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25

POWER SUPPLY

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-1221	Resistor, Comp., 33 ohms, 10%, 1/4 watt	130-0330-25
S-1206	Slide Switch, 14-28V	031-0035-01
T-1201	Transformer, Inverter	019-7013-00
TP-1201	Test Point, (Orange)	010-0002-00
TP-1202	Test Point, (Orange)	010-0002-00
TP-1203	Test Point, (Orange)	010-0002-00
TP-1204	Test Point, (Orange)	010-0002-00
TP-1205	Test Point, (Orange)	010-0002-00
TP-1206	Test Point, (Orange)	010-0002-00
TP-1207	Test Point, (Orange)	010-0002-00
TP-1208	Test Point, (Orange)	010-0002-00

COMPONENTS AND BENCH TEST KIT

REF. SYMBOL	DESCRIPTION	PART NUMBER
	Receiver/Transmitter Unit	C582601-0101
	Indicator	C582601-0201
	Channel Selector	C582601-0202
	Antenna Connector, Type "N" Improved	030-0020-01
	Antenna Connector, Type "N" Right Angle Improved	030-0024-00
	KA-15, L-Band Antenna	071-1004-00
	Co-AK Antenna Cable RG-8/U (10 ft)	024-0001-00
	Connector 32 Pin, #KPT06B 18-32S	030-2055-00
	Connector 32 Pin, #KPT06B 18-32P	030-2056-00
	Connector 23 Pin, #KPT06B 16-23S	030-2063-00
	BNC Connector, UG-88/U	030-0005-00
	Rack Assembly	071-4002-00
	Cessna DME 800 Bench Test Kit	SK320-34

INDICATOR

SERVO BOARD NO. 1

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-101	Capacitor, Tantalum, 1.0uf, 20%, 35 WVDC	096-1030-02
C-102	Capacitor, Mylar, .047uf, 10%, 200 WVDC	105-0018-74
C-103	Capacitor, Mylar, 0.1uf, 10%, 200 WVDC	105-0018-86
C-104	Capacitor, Mylar, .047uf, 10%, 200 WVDC	105-0018-74
C-105	Capacitor, Mylar, .047uf, 10%, 200 WVDC	105-0018-74
C-106	Capacitor, Tantalum, 0.12uf, 10%, 35 WVDC	096-1029-00
C-107	Capacitor, Tantalum, 1.0uf, 20%, 35 WVDC	096-1030-02
C-108	Capacitor, Mylar, 1Kpf, 10%, 200 WVDC	105-0018-14
C-109	Capacitor, Tantalum, 6.8uf, 20%, 20 WVDC	096-1030-04
C-110	Capacitor, Tantalum, 2.2uf, 20%, 20 WVDC	096-1007-00
CR-101	Diode, Zener, 7.5V, 10%	007-5003-00
CR-102	Diode, Silicon	007-6029-00
CR-103	Diode, Silicon	007-6029-00
CR-104	Diode, Silicon	007-6029-00
Q-101	Transistor, Silicon	007-0026-01
Q-102	Transistor, Silicon	007-0026-01
Q-103	Transistor, Silicon	007-0031-00
Q-104	Transistor, Silicon	007-0044-00
Q-105	Transistor, Silicon	007-0031-00
Q-106	Transistor, Silicon	007-0035-00
Q-107	Transistor, Silicon	007-0035-00
Q-108	Transistor, Silicon	007-0038-00
R-101	Resistor, Variable, 2K ohms, Velocity Reference Adj.	133-0030-00
R-102	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-103	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-104	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-105	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-106	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-107	Resistor, Comp., 510 ohms, 5%, 1/4 watt	130-0511-23
R-108	Resistor, Comp., 270K ohms, 10%, 1/4 watt	130-0274-25
R-109	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25
R-110	Resistor, Comp., 8.2K ohms, 10%, 1/4 watt	130-0822-25
R-111	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-112	Resistor, Comp., 18K ohms, 10%, 1/4 watt	130-0183-25
R-113	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-114	Resistor, Comp., 18K ohms, 10%, 1/4 watt	130-0183-25
R-115	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-116	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-117	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-118	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
T-101	Transformer, 400 Cycle Chopper	019-5035-00

SERVO BOARD NO. 2

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-201	Capacitor, Tantalum, 22uf, 20%, 20 V	096-1023-00
C-202	Capacitor, Mylar, 5uf, 20%, 50 V	105-0028-00
C-203	Capacitor, Tantalum, 150uf, 10%, 15 V	096-1027-00
C-204	Capacitor, Tantalum, 470uf, 10%, 35 V	096-1025-00
C-205	Capacitor, Tantalum, 47uf, 10%, 35 V	096-1025-00
C-206	Capacitor, Ceramic, 1Kpf, 10%, 400 WVDC, X5F	113-5102-00
C-207	Capacitor, Cermaic, .01uf, +80 -20%, 50 V	113-6103-00
CR-201	Diode, Silicon	007-6029-00
CR-202	Diode, Silicon	007-6029-00
CR-203	Diode, Silicon	007-6029-00
Q-201	Transistor, Silicon	007-0026-01
Q-202	Transistor, Silicon	007-0043-00
Q-203	Transistor, Silicon	007-0035-00
Q-204	Transistor, Silicon	007-0031-00
Q-205	Reference Amplifier	015-0002-00
Q-206	Transistor, Silicon	007-0026-01
Q-207	Transistor, Silicon	007-0026-01
R-201	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-202	Resistor, Comp., 470K ohms, 10%, 1/4 watt	130-0474-25
R-203	Resistor, Comp., 470K ohms, 10%, 1/4 watt	130-0474-25
R-204	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-205	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-206	Resistor, Comp., 100 ohms, 10%, 1/4 watt	130-0101-25
R-207	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-208	Resistor, Precision, 30.1K ohms, 1%, 1/4 watt	136-3012-22
R-209	Resistor, Variable, 2K ohms, 10%, 1/2 watt	133-0030-00
R-210	Resistor, Comp., 6.8K ohms, 10%, 1/4 watt	130-0682-25
R-211	Resistor, Precision, 2.0K ohms, 5%, 1/4 watt	135-0202-32
R-211	Resistor, Comp., 2.0K ohms, 1%, 1/4 watt	135-2001-22
R-212	Resistor, Precision, 2.2K ohms, 5%, 1/4 watt	135-0222-32
R-212	Resistor, Comp., 2.21K ohms, 1%, 1/4 watt	136-2211-22
R-213	Resistor, Comp., 4.7K ohms, 5%, 1/4 watt	130-0472-23
R-214	Resistor, Comp., 4.7K ohms, 5%, 1/4 watt	130-0472-23
R-215	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-216	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-217	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-218	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-219	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-220	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-221	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-222	Resistor, Comp., 560K ohms, 5%, 1/4 watt	130-0564-23
R-223	Resistor, Precision, 180K ohms, 5%, 1/2 watt	135-0184-42
R-223	Resistor, Precision, 182K ohms, 1%, 1/4 watt	136-1823-22
R-224	Resistor, Precision, 180K ohms, 5%, 1/2 watt	135-0184-42
R-225	Resistor, Precision, 270K ohms, 5%, 1/2 watt	135-0274-42
R-225	Resistor, Precision, 274K ohms, 1%, 1/4 watt	136-2743-22
R-226	Resistor, Precision, 270K ohms, 5%, 1/2 watt	135-0274-42
R-227	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-35

SERVO BOARD NO. 3

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-301	Capacitor, Ceramic, 4.7Kpf, +80 -20%, 500 WVDC, Z5U	114-6472-00
C-302	Capacitor, Tantalum, 1.0uf, 20%, 35 V	096-1005-00
C-303	Capacitor, Tantalum, 1.0uf, 20%, 35 V	096-1005-00
C-304	Capacitor, Tantalum, 22uf, 20%, 35 V	096-1011-00
CR-301	Diode, Silicon	007-6029-00
CR-302	Diode, Zener, 16V, 10%	007-5009-00
CR-303	Diode, Silicon	007-6029-00
CR-304	Diode, Zener, 16V, 10%	007-5009-00
CR-305	Diode, Silicon	007-6029-00
Q-301	Transistor, Silicon	007-0035-00
Q-302	Transistor, Silicon	007-0035-00
Q-303	Transistor, Silicon	007-0031-00
Q-304	Transistor, Silicon	007-0035-00
Q-305	Transistor, Silicon	007-0026-01
Q-306	Transistor, Silicon	007-0047-00
Q-307	Transistor, Silicon	007-0043-00
Q-307	Transistor, Germanium	007-0085-00
Q-308	Transistor, Silicon	007-0031-00
R-301	Resistor, Comp., 220 ohms, 10%, 1/4 watt	130-0221-25
R-302	Resistor, Comp., 220K ohms, 10%, 1/4 watt	130-0224-25
R-303	Resistor, Variable, 10%, 1/2 watt, Velocity Zero Adj.	133-0029-00
R-304	Resistor, Comp., 470K ohms, 10%, 1/4 watt	130-0474-25
R-305	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-306	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-307	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-308	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-309	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-310	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-311	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-312	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-313	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-314	Resistor, Comp., 4.7K ohms, 10%, 1/4 watt	130-0472-25
R-315	Resistor, Comp., 18K ohms, 10%, 1/4 watt	130-0183-25
R-316	Resistor, Variable, 10K ohms, 10%, 1/2 watt, Interp. Cal. Adj.	133-0029-00
R-317	Resistor, Comp., 470 ohms, 10%, 1/4 watt	130-0471-25
R-318	Resistor, Comp., 150 ohms, 10%, 1/4 watt	130-0151-25
R-319	Resistor, Comp., 10K ohms, 10%, 1/4 watt	130-0103-25

SERVO BOARD NO. 4

REF. SYMBOL	DESCRIPTION	PART NUMBER
CR-401	Diode, Germanium	007-6023-00
CR-402	Diode, Germanium	007-6023-00
CR-403	Diode, Germanium	007-6023-00
CR-404	Diode, Germanium	007-6023-00
CR-405	Diode, Germanium	007-6023-00
CR-406	Diode, Germanium	007-6023-00
CR-407	Diode, Germanium	007-6023-00
CR-408	Diode, Germanium	007-6023-00
Q-401	Transistor, Silicon	007-0034-00
Q-402	Transistor, Silicon	007-0034-00
Q-403	Transistor, Silicon	007-0034-00
Q-404	Transistor, Silicon	007-0034-00
Q-405	Transistor, Silicon	007-0034-00
Q-406	Transistor, Silicon	007-0034-00
Q-407	Transistor, Silicon	007-0034-00
Q-408	Transistor, Silicon	007-0034-00
Q-409	Transistor, Silicon	007-0034-00
Q-410	Transistor, Silicon	007-0034-00
Q-411	Transistor, Silicon	007-0034-00
Q-412	Transistor, Silicon	007-0034-00
Q-413	Transistor, Silicon	007-0034-00
Q-414	Transistor, Silicon	007-0034-00
Q-415	Transistor, Silicon	007-0034-00
Q-416	Transistor, Silicon	007-0034-00
Q-417	Transistor, Silicon	007-0034-00
Q-418	Transistor, Silicon	007-0034-00
Q-419	Transistor, Silicon	007-0034-00
Q-420	Transistor, Silicon	007-0034-00
R-401	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-402	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-403	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-404	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-405	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-406	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-407	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-408	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-409	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-410	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-411	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-412	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-413	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-414	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-415	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-416	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-417	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-418	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-419	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-420	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-421	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-422	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-423	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-424	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-425	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-426	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-427	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-428	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-429	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-430	Resistor, Precision, 7.51K ohms, .25%, 1/4 watt	136-7511-76
R-431	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-432	Resistor, Precision, 11.7K ohms, .25%, 1/4 watt	136-1172-76
R-433	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-434	Resistor, Precision, 20K ohms, .5%, 1/4 watt	136-2002-71

SERVO BOARD NO. 4

REF. SYMBOL	DESCRIPTION	PART NUMBER
R-435	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-436	Resistor, Precision, 45K ohms, .5%, 1/4 watt	136-4502-71
R-437	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-438	Resistor, Precision, 95K ohms, .5%, 1/4 watt	136-9502-71
R-439	Resistor, Comp., 5.1K ohms, 5%, 1/4 watt	130-0512-23
R-440	Resistor, Precision, 121K ohms, 1%, 1/4 watt	136-1213-72
R-441	Resistor, Comp., 5.1K ohms, 5%, 1/4 watt	130-0512-23
R-442	Resistor, Precision, 162K ohms, 1%, 1/4 watt	136-1623-72
R-443	Resistor, Comp., 5.1K ohms, 5%, 1/4 watt	130-0512-23
R-444	Resistor, Precision, 243K ohms, 1%, 1/4 watt	136-2433-72
R-445	Resistor, Comp., 5.1K ohms, 5%, 1/4 watt	130-0512-23
R-446	Resistor, Comp., 510K ohms, 5%, 1/4 watt	130-0514-23
R-447	Resistor, Comp., 5.1K ohms, 5%, 1/4 watt	130-0512-23
R-448	Resistor, Comp., 1 Meg ohms, 5%, 1/4 watt	130-0105-23
R-449	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-450	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-451	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-452	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-453	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-454	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-455	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-456	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25

SERVO BOARD NO. 5

REF. SYMBOL	DESCRIPTION	PART NUMBER
C-501	Capacitor, Tantalum, 1uf, 20%, 35 V	096-1030-02
C-502	Capacitor, Tantalum, 100uf, 20%, 15 V	096-1030-08
CR-501	Diode, Zener, 16 V, 10%	007-5009-00
Q-501	Transistor, Silicon	007-0034-00
Q-502	Transistor, Silicon	007-0034-00
Q-503	Transistor, Silicon	007-0032-00
Q-504	Transistor, Silicon	007-0032-00
Q-505	Transistor, Silicon	007-0035-00
R-501	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-502	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-503	Resistor, Comp., 22K ohms, 10%, 1/4 watt	130-0223-25
R-504	Resistor, Precision, 4.99K ohms, .25%, 1/4 watt	136-4991-76
R-505	Resistor, Precision, 5.01K ohms, .25%, 1/4 watt	136-5011-76
R-506	Resistor, Precision, 725 ohms, .25%, 1/4 watt	136-7250-76
R-506	Resistor, Precision, 733 ohms, 0.25%, 1/4 watt	136-7330-26
R-507	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-508	Resistor, Comp., 47K ohms, 10%, 1/4 watt	130-0473-25
R-509	Resistor, Comp., 56K ohms, 10%, 1/4 watt	130-0563-25
R-510	Resistor, Comp., 100K ohms, 10%, 1/4 watt	130-0104-25
R-511	Resistor, Variable, 2K ohms, 10%, 1/2 watt	133-0030-00
R-512	Resistor, Comp., 2.2K ohms, 10%, 1/4 watt	130-0222-25
R-513	Resistor, Comp., 68K ohms, 10%, 1/4 watt	130-0683-25
R-514	Resistor, Comp., 220K ohms, 10%, 1/4 watt	130-0224-25
R-515	Resistor, Comp., 3.6K ohms, 5%, 1/4 watt	130-0362-23
R-516	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-517	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25
R-518	Resistor, Comp., 1K ohms, 10%, 1/4 watt	130-0102-25

FRAME COMPONENTS

REF. SYMBOL	DESCRIPTION	PART NUMBER
DS-601	Bulb, 14V	037-0007-01
DS-601	Lamp, Miniature	037-0012-01
DS-602	Bulb, 14V	037-0007-01
DS-601	Bulb, 28V	037-0007-02
DS-602	Bulb, 28V	037-0007-02
DS-602	Lamp, Miniature	037-0012-01
DS-603, 604, 605	Lamp, Miniature	037-0012-01
I-601	Indicator, 1/10 Mile	023-0007-00
I-602	Indicator, 1 Mile	023-0007-00
I-603	Indicator, 10 Mile	023-0007-00
I-604	Indicator, 100 Mile	023-0008-00
J-601	Connector	030-2056-00
M-601	Motor/w/o Gear	148-5001-00
M-601	Motor/w/ Gear	148-5001-01
R-601	Variable Resistor, 10 Turn Potentiometer	133-0025-00
S-601	Switch, (Omni 1 - Hold/Omni 2 - Switch)	031-0049-01
S-602	Switch, KTS-TTS	031-0049-00

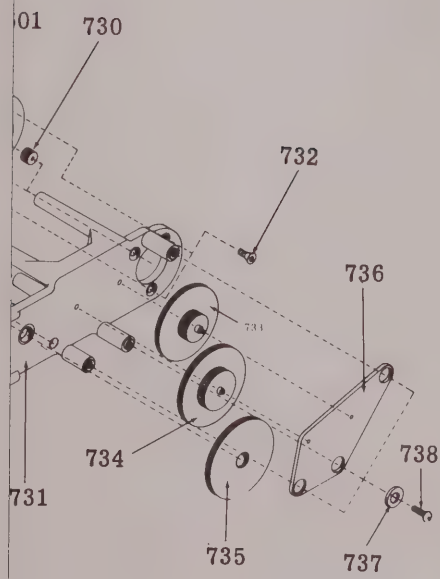
FRONT ASSEMBLY

REF. SYMBOL	DESCRIPTION	PART NUMBER
701	Knob, (2)	073-0043-00
703	Screw, No. 0-80 x .187, (2)	089-5103-03
704	Face Plate	088-0061-01
705	Flag Assembly	250-1056-65
706	Light Diffuser	088-0078-00
707	Screw, No. 2-56 x .250	089-5005-04
708	Washer, Internal Tooth Lock, (2)	089-8012-22
709	Light Holder, (2)	072-0041-00
710	Hex Nuts, 1/4-28	089-2123-10
711	Washer, Internal Tooth Lock, (2)	089-8020-22
712	Screw, No. 4-40 x .312, (11)	089-5222-05
713	Front Mounting Plate	073-0038-00
714	Washer, Extruded, (2)	091-0036-00
715	Contact Spring, (2)	047-1173-00
716	Washer, Flat Fiber, (2)	091-0037-00
717	Screw, No. 4-40 x .250, (2)	
718	Hex Spacer, 2.812 Long, (4)	076-0057-00
719 Ref.	Printed Circuit Board, Servo No. 1	009-5026-00
720	Screw, Hex Head No. 2-56	
721	Clamp, Gear	029-0022-00
722	Gear, Potentiometer	029-0016-00
723	Screw, No. 4-40 x .312, (3)	089-5324-05
724	Gear and Shaft	029-0018-00
725	Odometer Housing and Pinion Shaft, Left Side	250-1056-66
726	Pinion, (2)	028-0001-00
727	Counter Wheel, (2)	028-0003-00
728	Counter Wheel	028-0002-00
729	Roll Pin, .062 x .375	090-0052-00
730	Pinion Motor	029-0021-00
731	Odometer Housing, (Right Side)	073-0039-00
732	Screw, No. 4-40 x .250, (3)	
733	Change Gear	029-0020-00
734	Change Gear	029-0019-00
735	Gear	029-0017-00
736	Bearing Plate	047-1209-00
737	Washer Flat No. 2	
738	Screw, No. 2-56 x .187, (3)	089-5569-03

CHANNEL SELECTOR

REF. SYMBOL	DESCRIPTION	PART NUMBER
CR-101	Diode	007-6021-00
CR-102	Diode	007-6021-00
CR-103	Diode	007-6021-00
CR-104	Diode	007-6021-00
DS-101	Light Bulb, #327, 28V, (Clear)	037-0007-02
DS-101	Light Bulb, #327R, 28V, (Red)	037-0007-04
J-101	Connector Assembly	030-2075-00
S-101	Switch Assembly	031-0055-00
S-102	Switch Assembly	031-0055-00
S-103	Switch Assembly	031-0055-00
S-104	Switch Assembly	031-0055-00
	Ground Lug	008-0004-00
	Contact Lug	008-0018-00
	Lock Tabs	030-1007-00
	Lever and Pivot	030-1008-00
	Hood, 20 Pin Connector	030-1010-00
	Connector, 20 Pin, Female	030-2002-00
	Connector, 20 Pin, Male	030-2003-00
	Light Contact	047-1102-00
	Front Mounting Plate	047-1264-00
	Rear Mounting Plate	047-1265-00
	Equipment Cover, Channel Selector	047-1266-00
	Rear Plate Support	047-1273-00
	Serial No. Tag	057-1105-01
	Spacer, (Light)	076-0044-05
	Knob, mc	088-0055-04
	Face Plate	088-0067-00
	Insert Adapter, Knob	088-0071-00
	Dial	088-0072-01
	Knob, kc	088-0072-00

719 REF.



nt Assembly

CHANNEL SELECTOR

REF. SYMBOL	DESCRIPTION	PART NUMBER
CR-101	Diode	007-6021-00
CR-102	Diode	007-6021-00
CR-103	Diode	007-6021-00
CR-104	Diode	007-6021-00
DS-101	Light Bulb, #327, 28V, (Clear)	037-0007-02
DS-101	Light Bulb, #327R, 28V, (Red)	037-0007-04
J-101	Connector Assembly	030-2075-00
S-101	Switch Assembly	031-0055-00
S-102	Switch Assembly	031-0055-00
S-103	Switch Assembly	031-0055-00
S-104	Switch Assembly	031-0055-00
	Ground Lug	008-0004-00
	Contact Lug	008-0018-00
	Lock Tabs	030-1007-00
	Lever and Pivot	030-1008-00
	Hood, 20 Pin Connector	030-1010-00
	Connector, 20 Pin, Female	030-2002-00
	Connector, 20 Pin, Male	030-2003-00
	Light Contact	047-1102-00
	Front Mounting Plate	047-1264-00
	Rear Mounting Plate	047-1265-00
	Equipment Cover, Channel Selector	047-1266-00
	Rear Plate Support	047-1273-00
	Serial No. Tag	057-1105-01
	Spacer, (Light)	076-0044-05
	Knob, mc	088-0055-04
	Face Plate	088-0067-00
	Insert Adapter, Knob	088-0071-00
	Dial	088-0072-01
	Knob, kc	088-0072-00

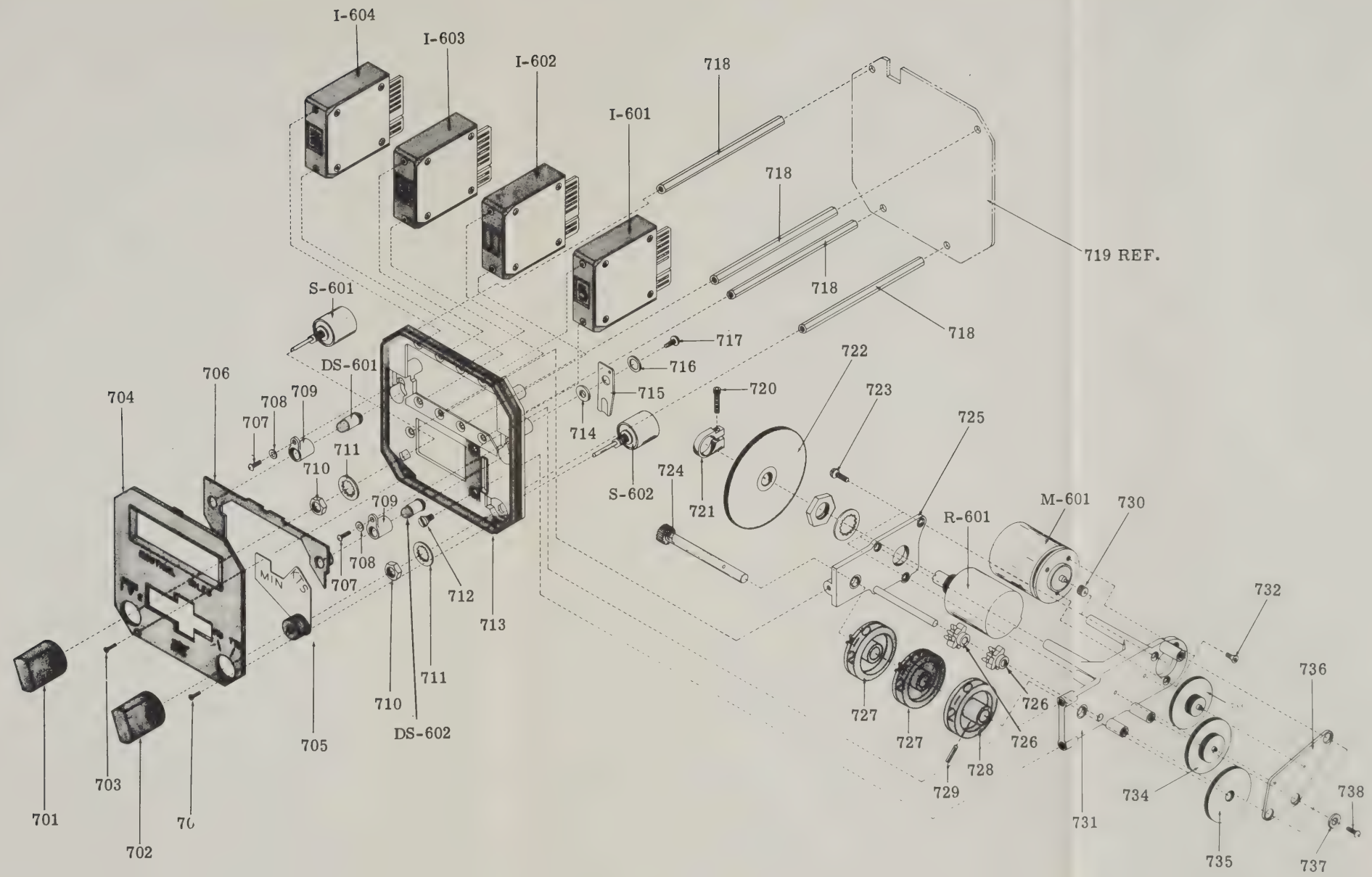


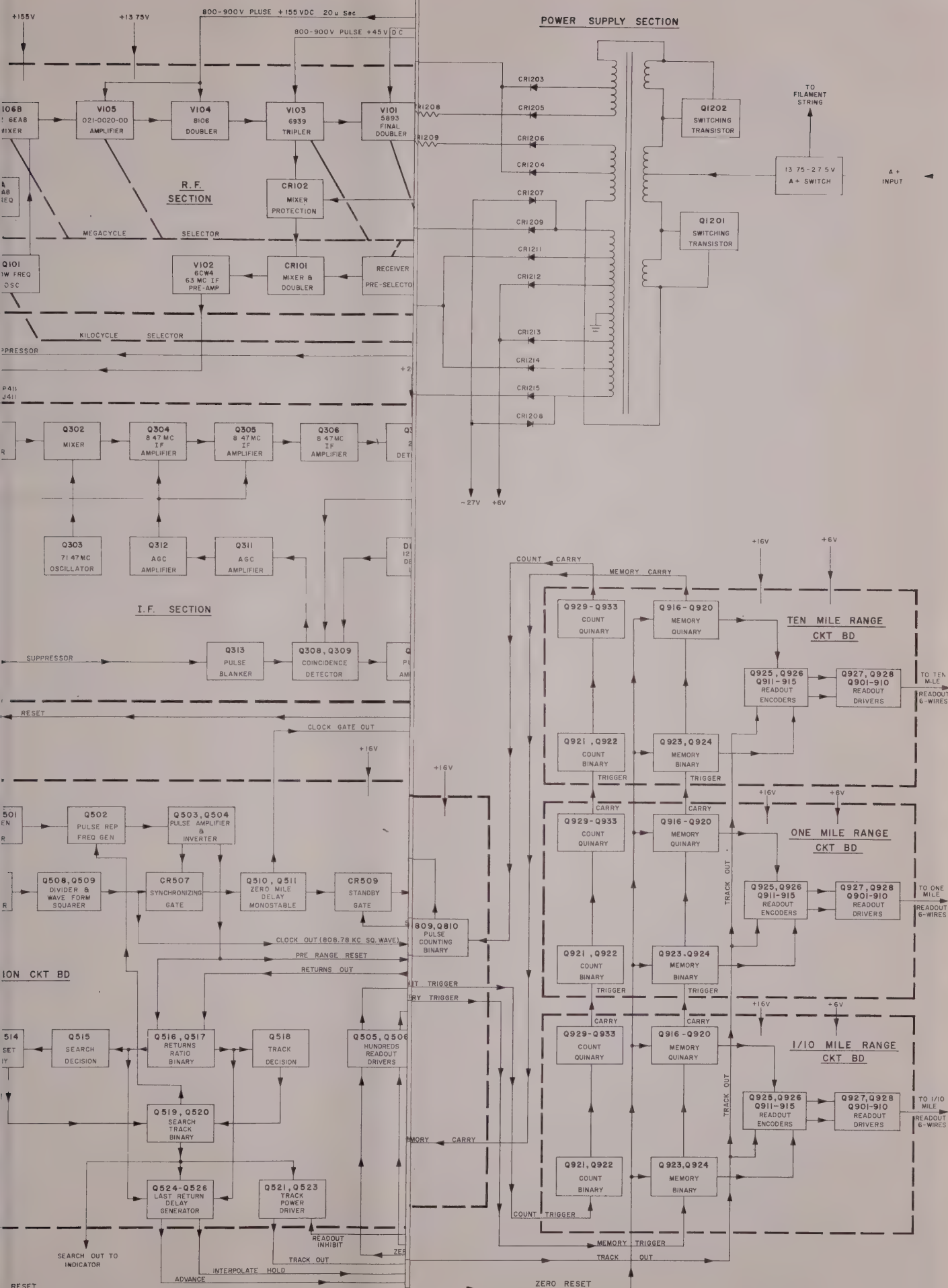
Figure 6-3. Cessna DME 800 Indicator Front Assembly

SECTION VII

Block Diagrams

And

Schematics



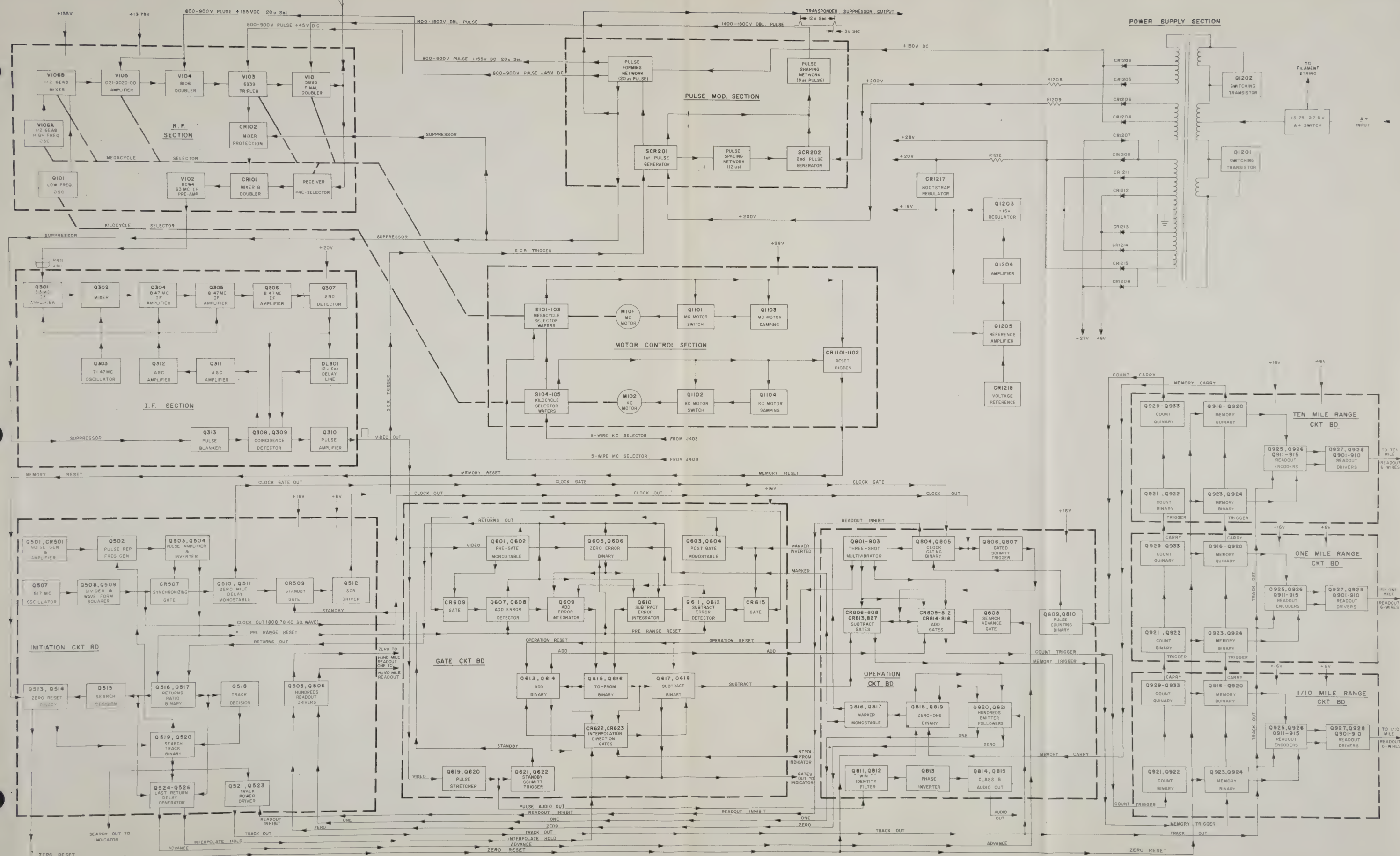
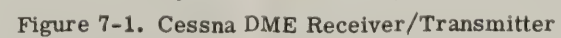
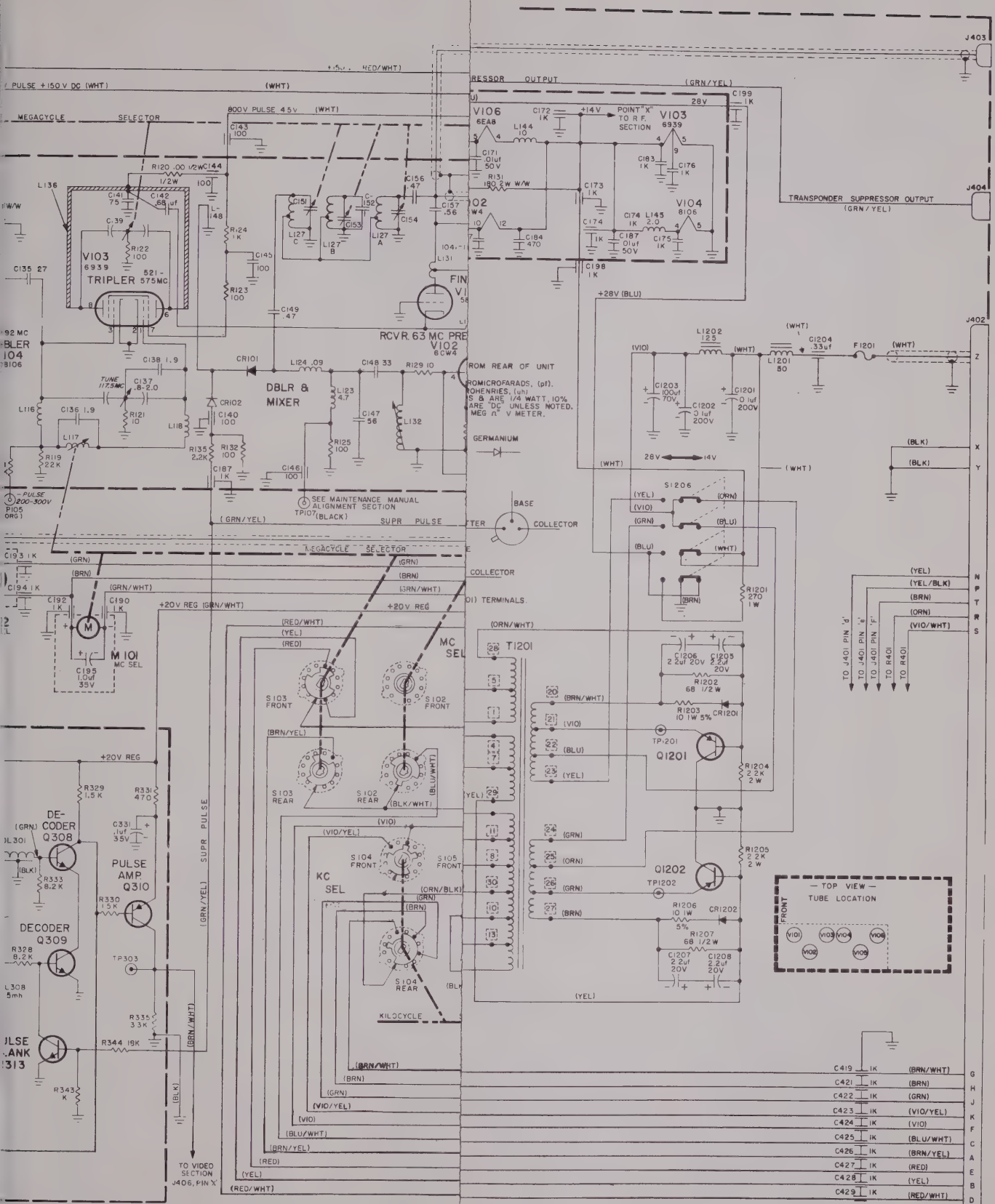
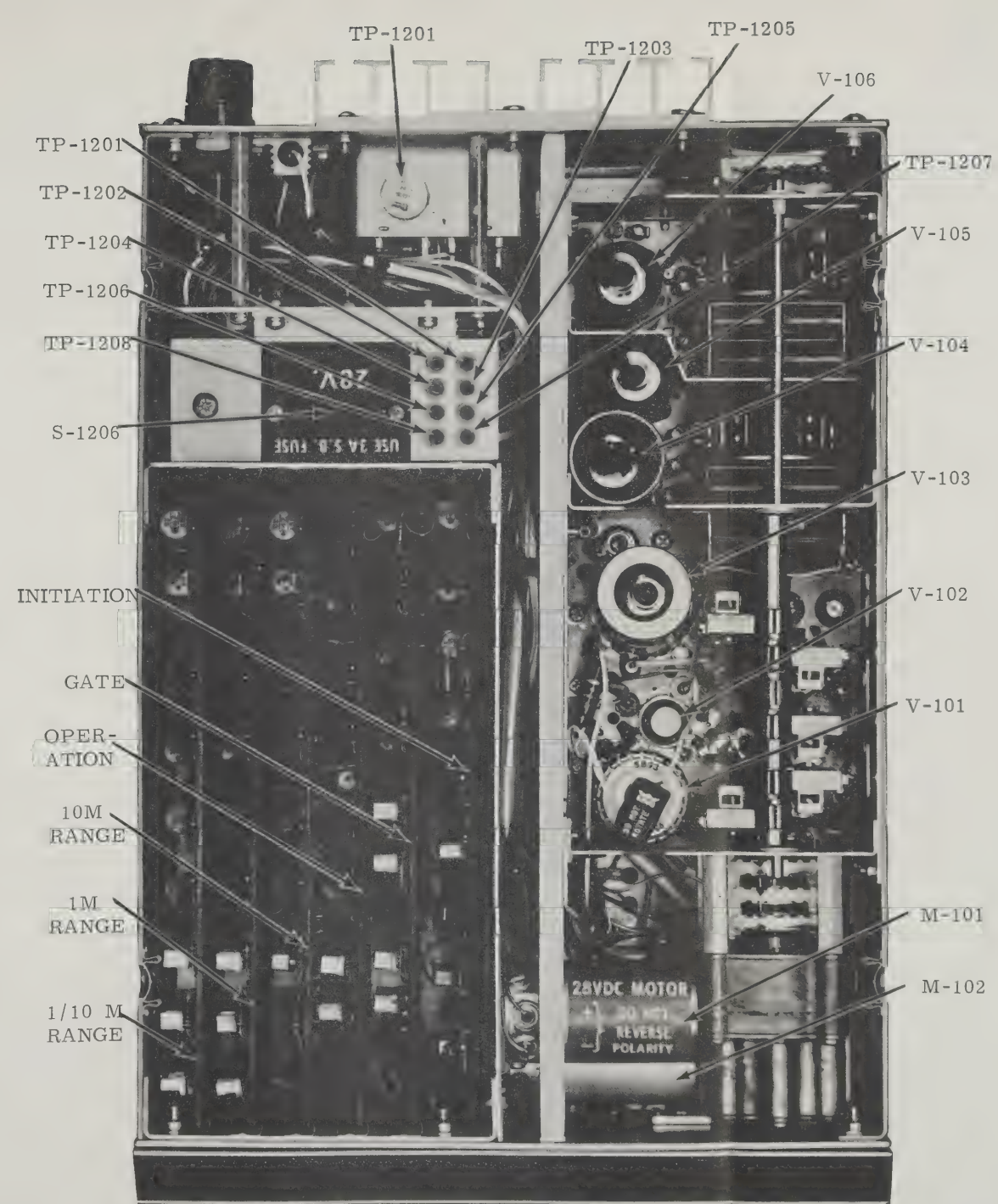
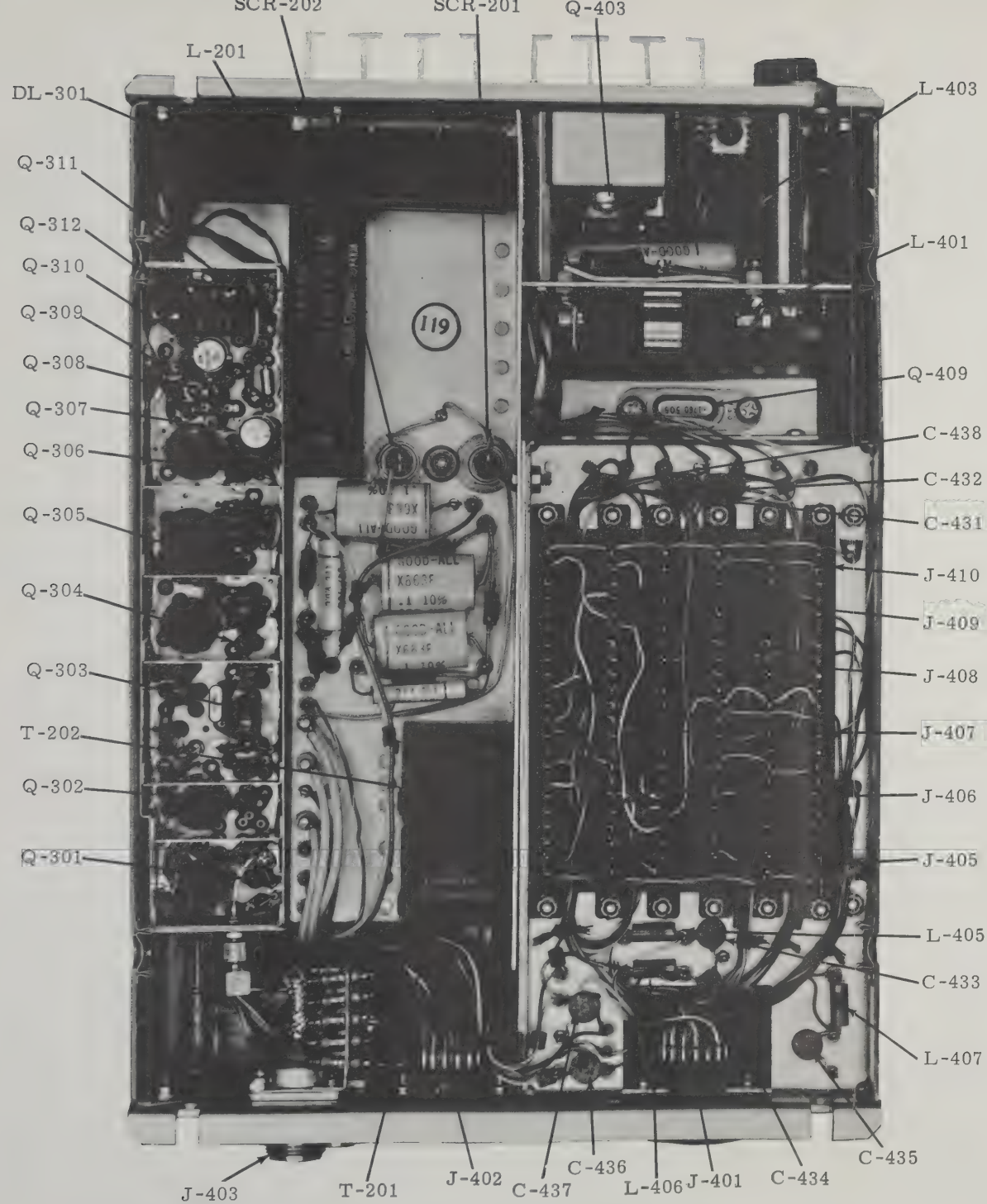


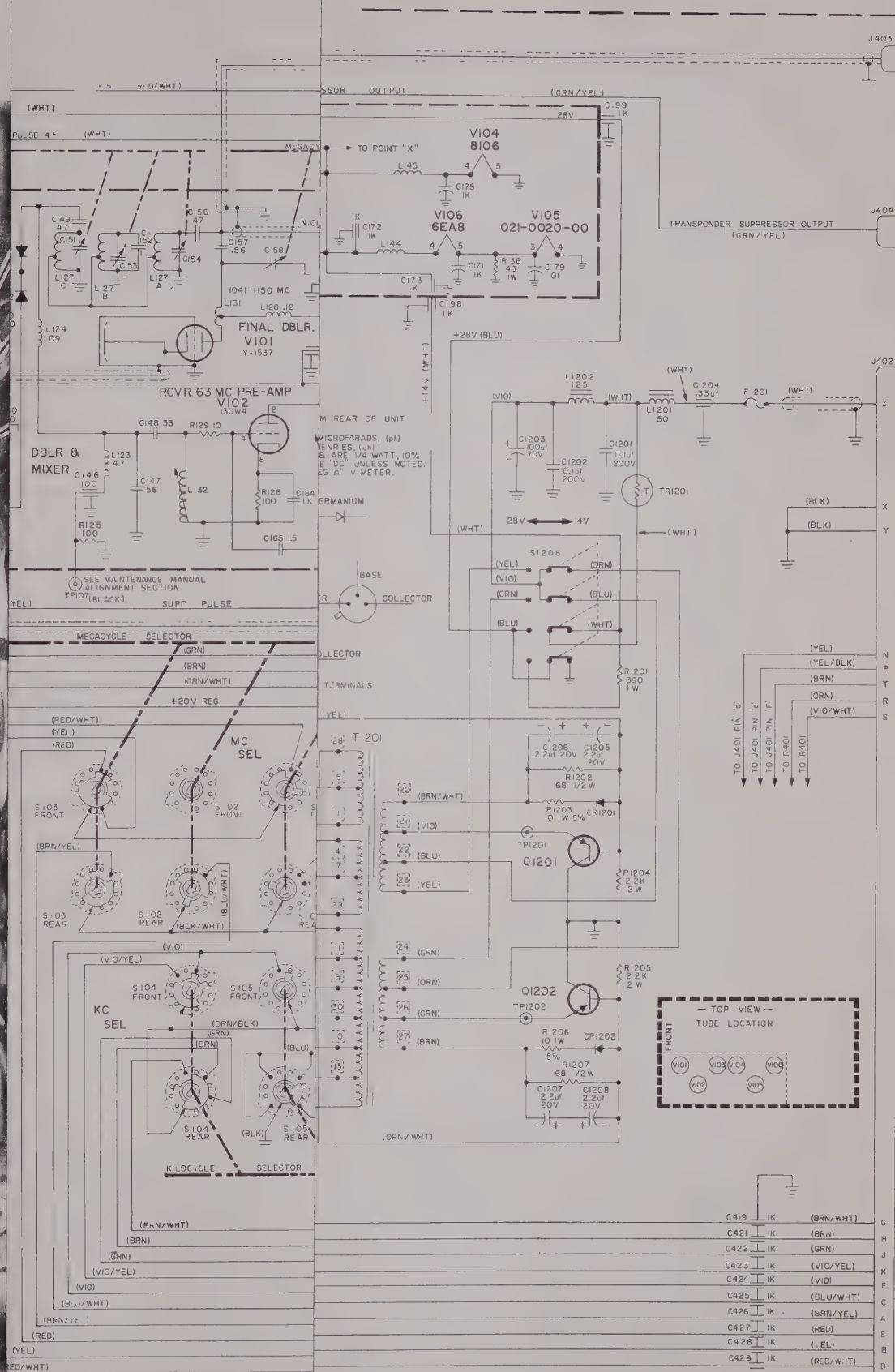
Figure 7-1. Cessna DME Receiver/Transmitter

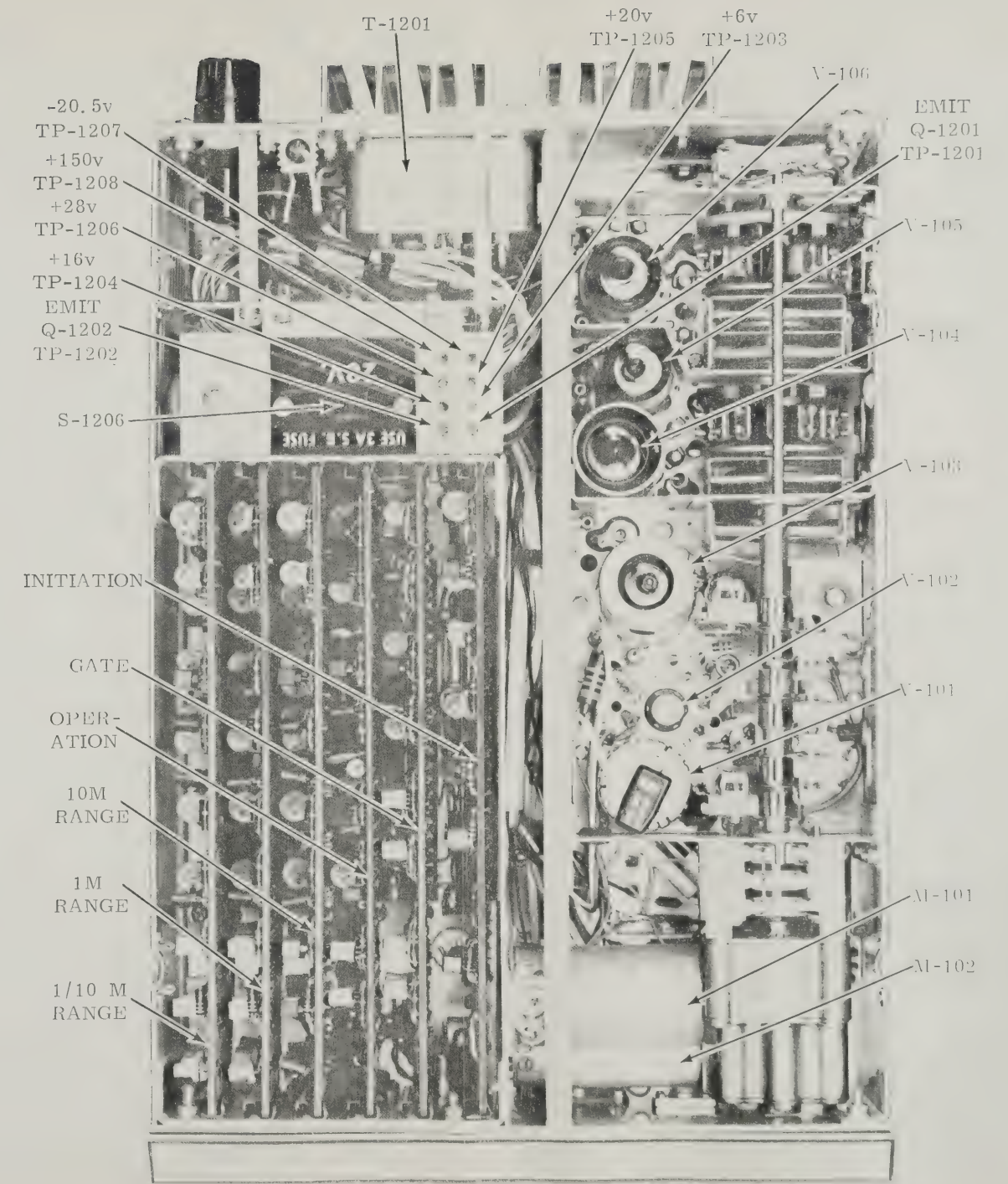
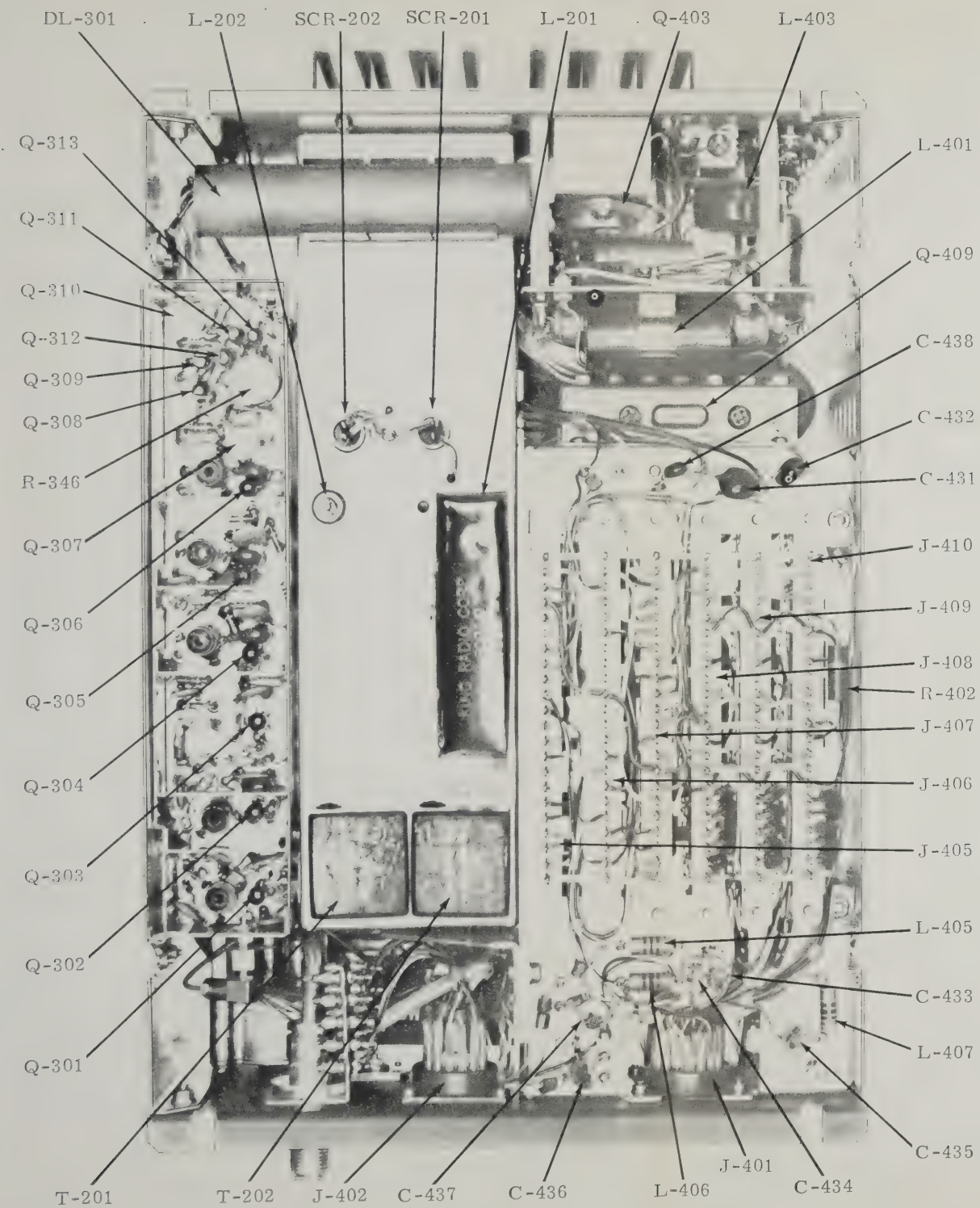




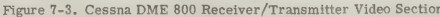












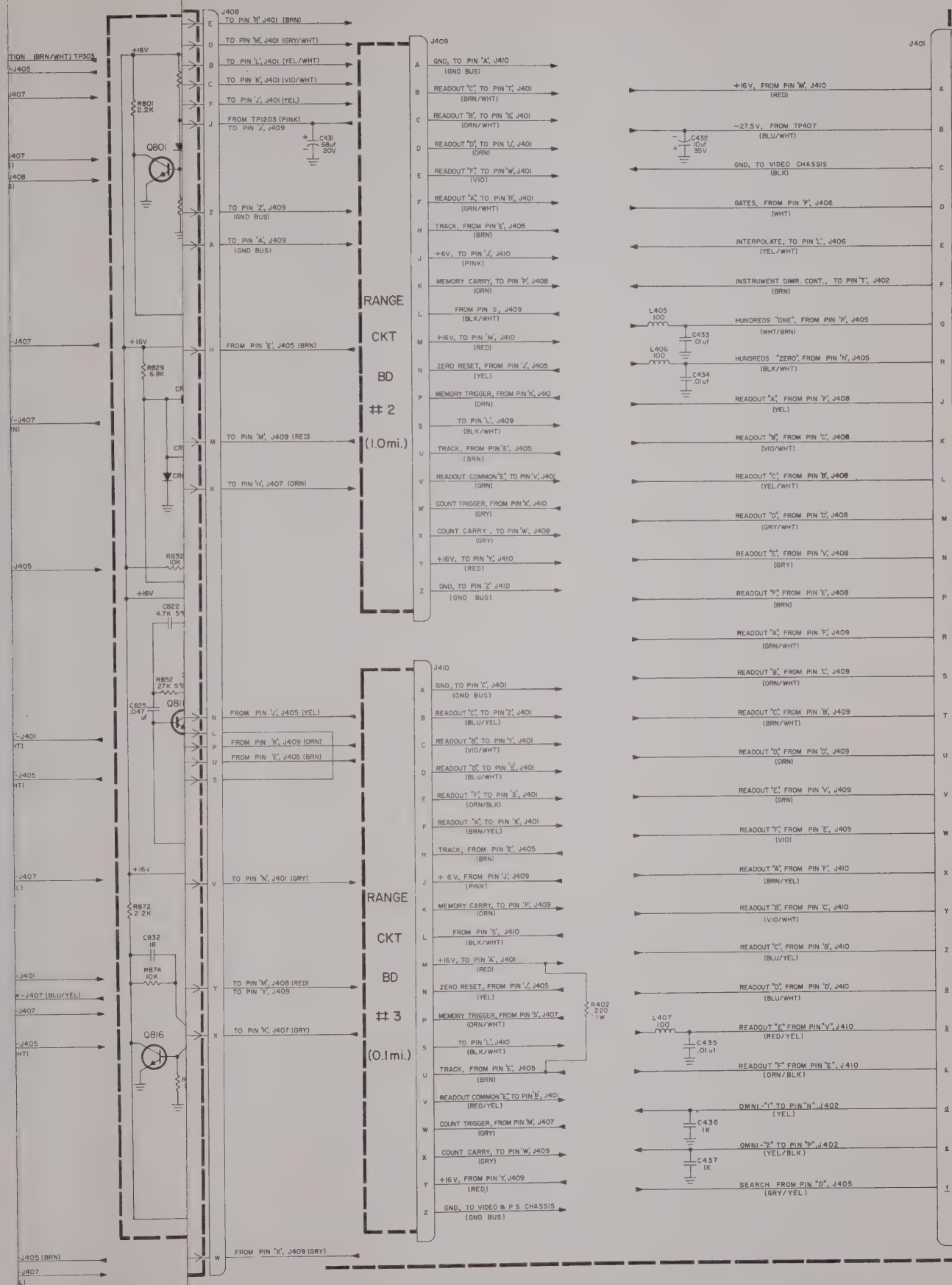


Figure 7-3A. Cessna DME 800 Receiver/Transmitter Video Section



Figure 7-3A. Cessna DME 800 Receiver/Transmitter Video Section

04

R-911

R-918

R-924

R-949

R-952

R-948

R-915

R-907

R-927

R-923

R-916

R-95

R-9

R

F

V

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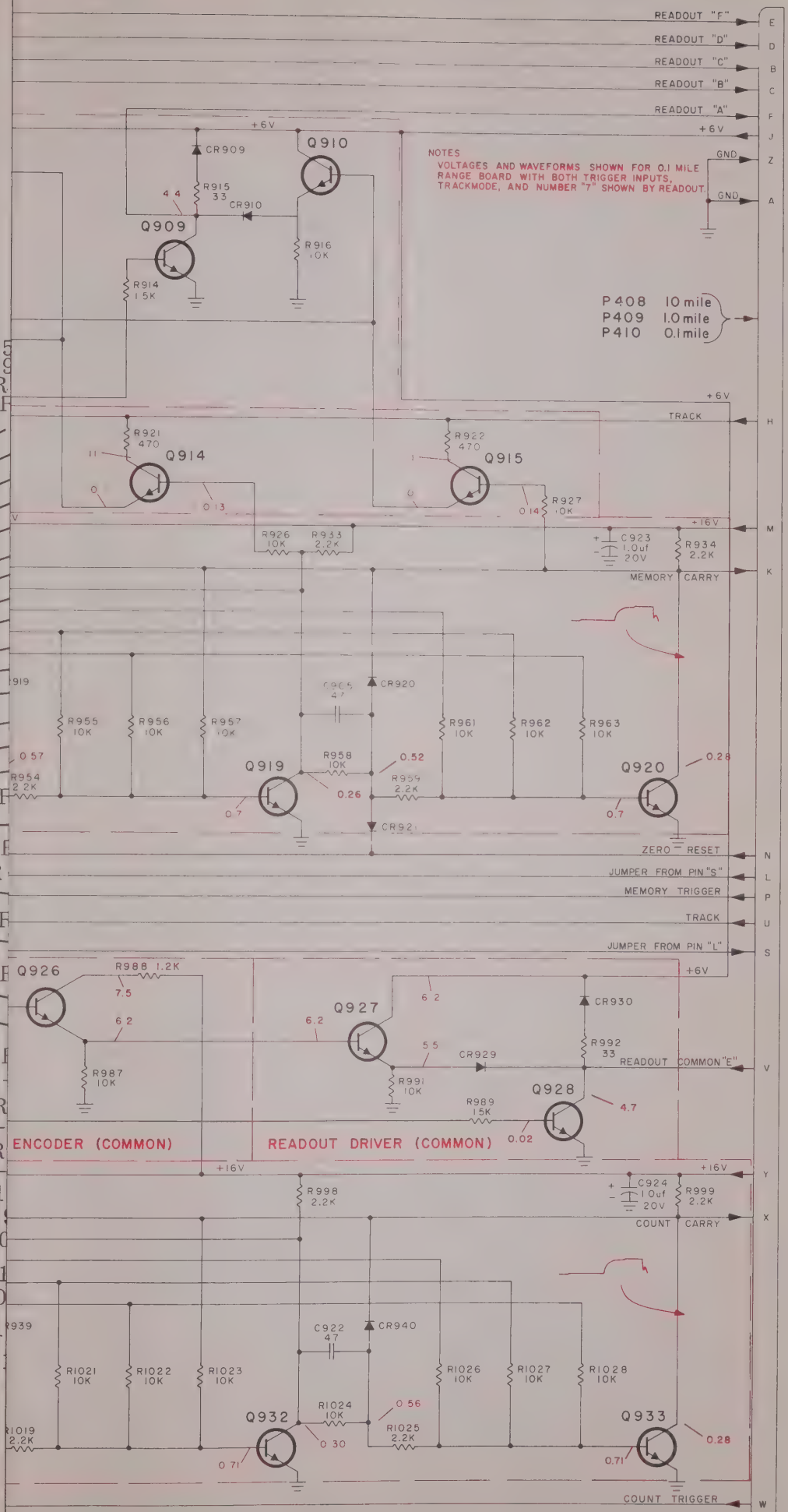
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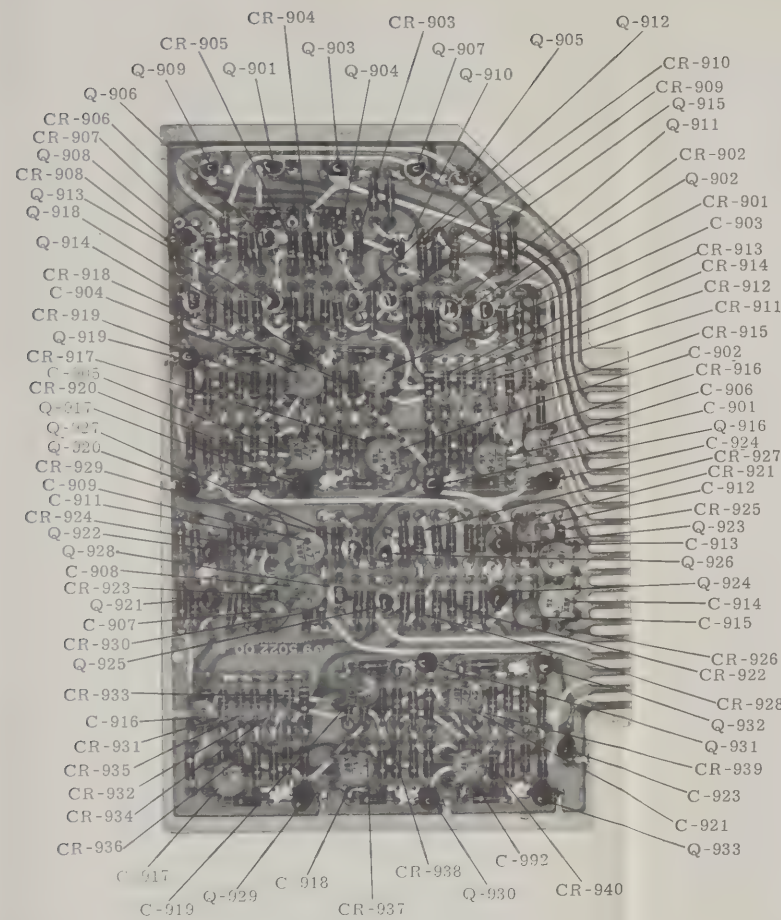
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R-1015

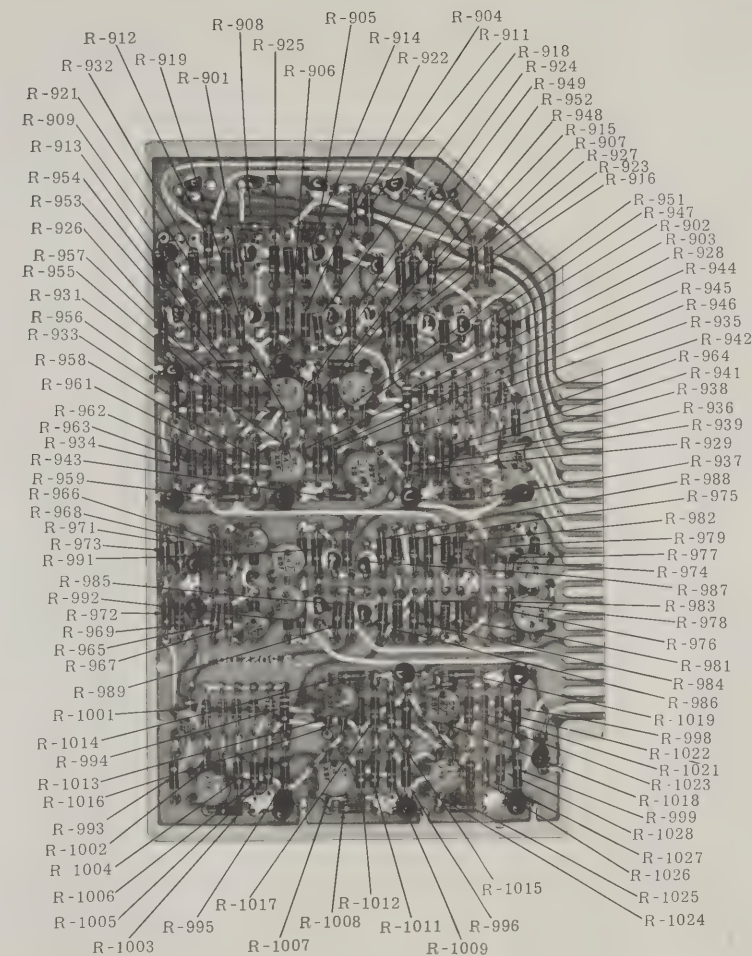
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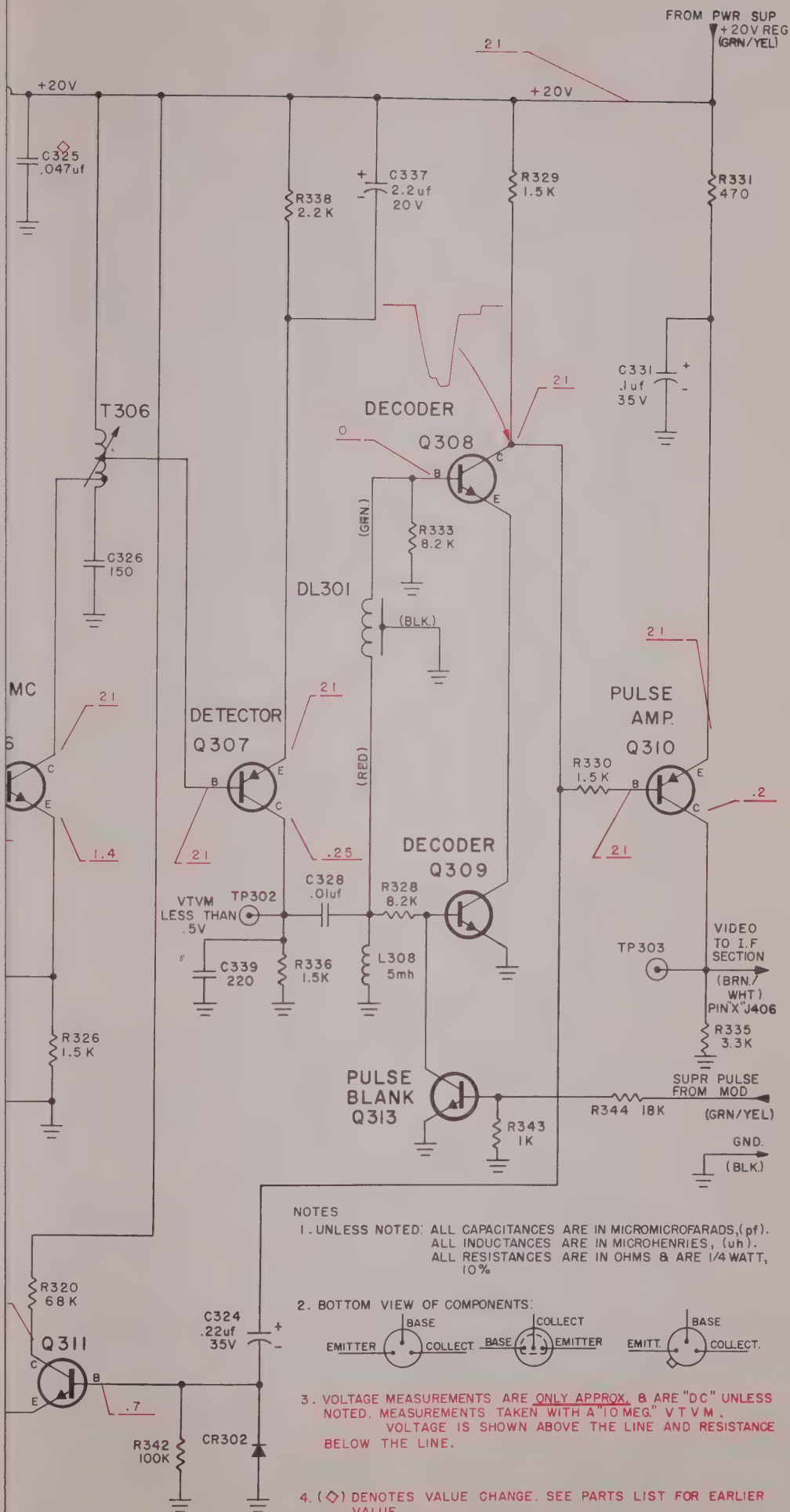


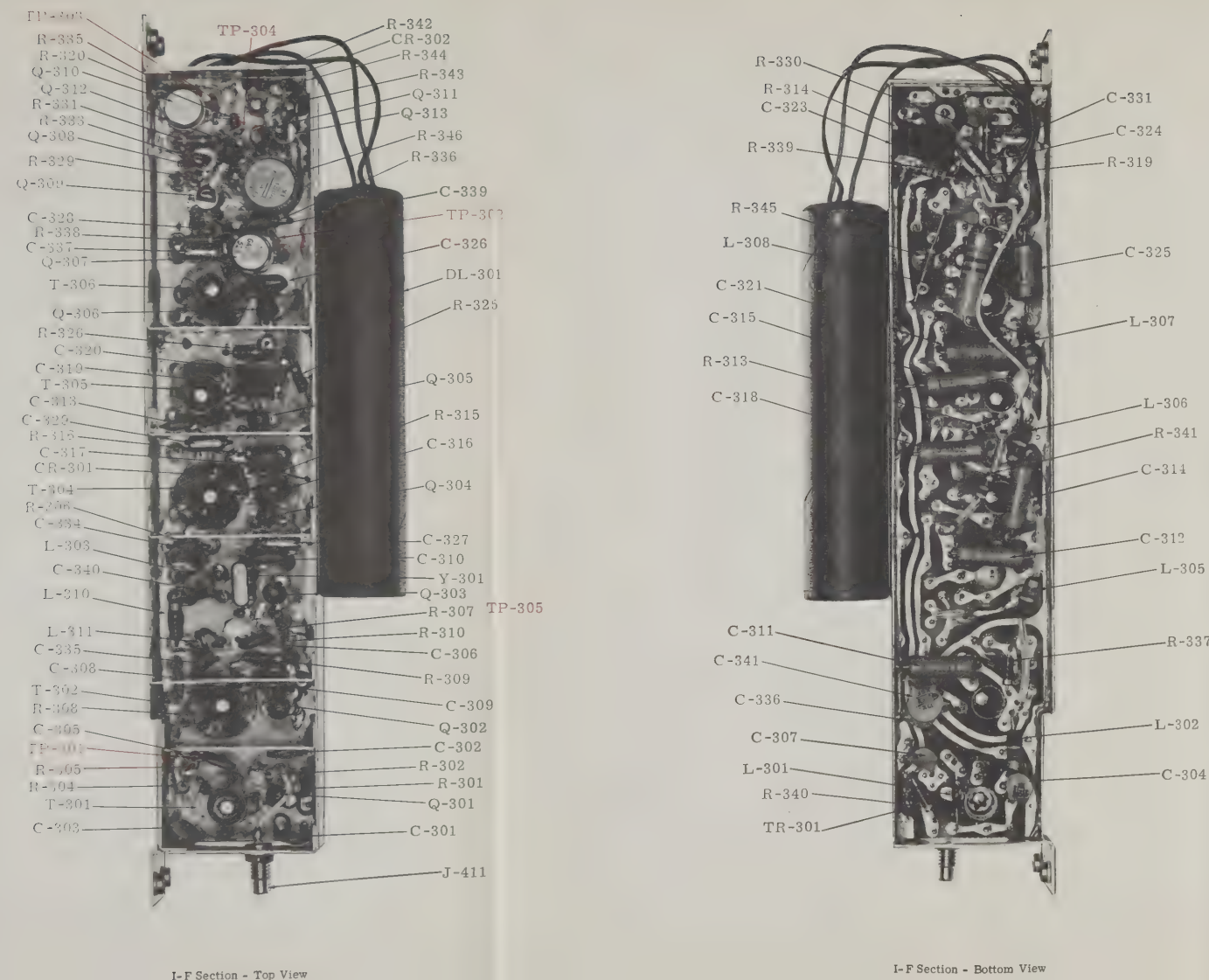
Range Circuit Board



Range Circuit Board-Resistors

Figure 7-4. Cessna DME 800 Receiver/Transmitter Range Circuit Board





I-F Section - Top View

I-F Section - Bottom View

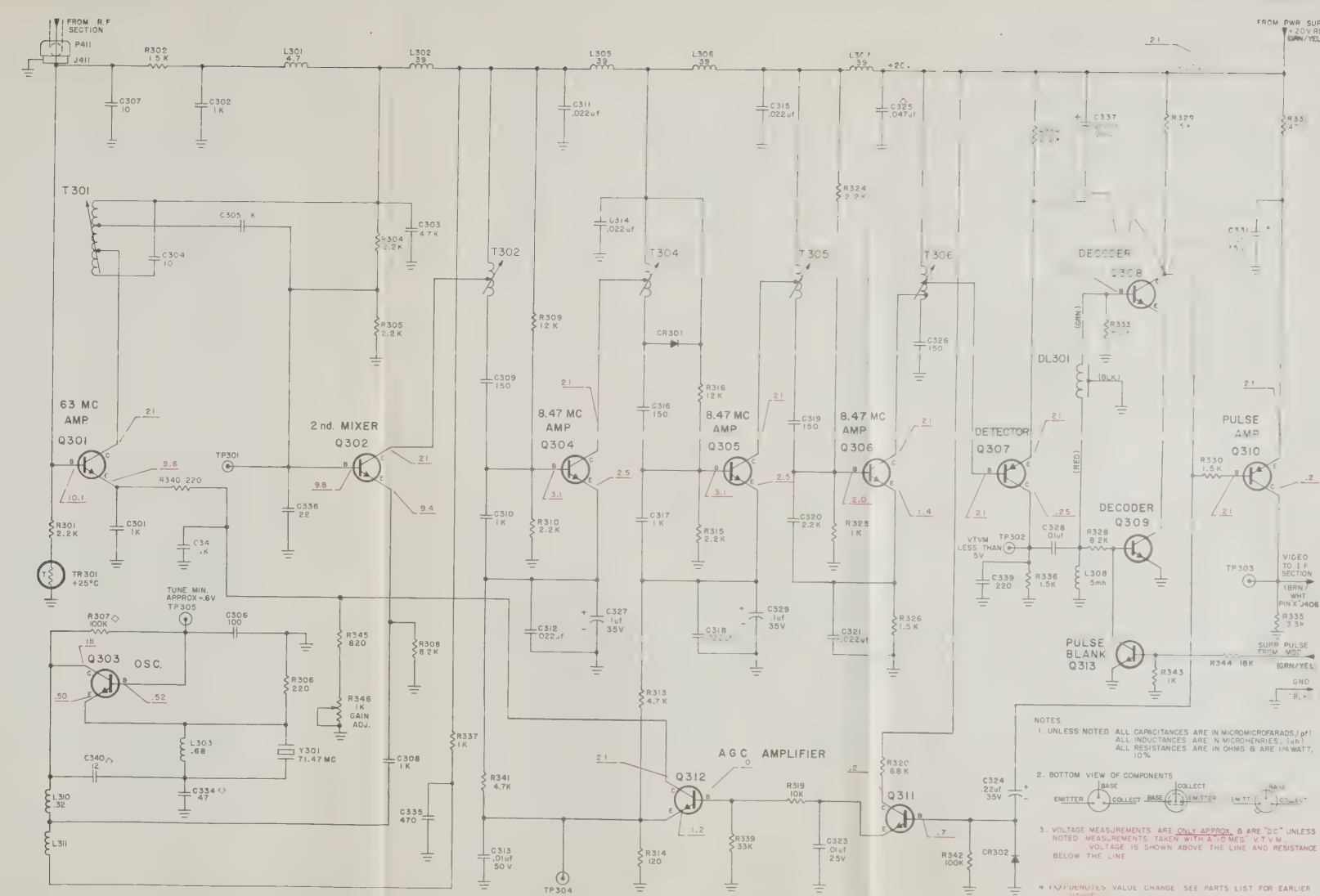
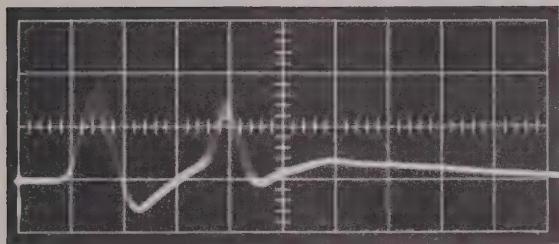
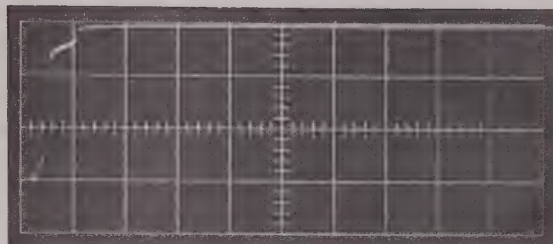


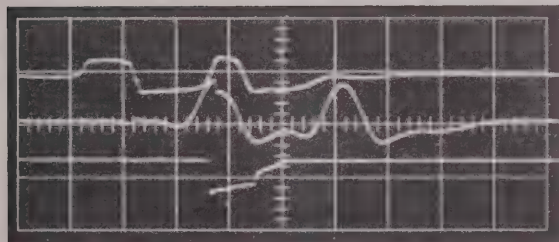
Figure 7-5. Cessna DME 800 Receiver/Transmitter I-F Section



Detector Output, TP-302
Vertical - 2 volts per cm.
Horizontal - 5 microseconds per cm.

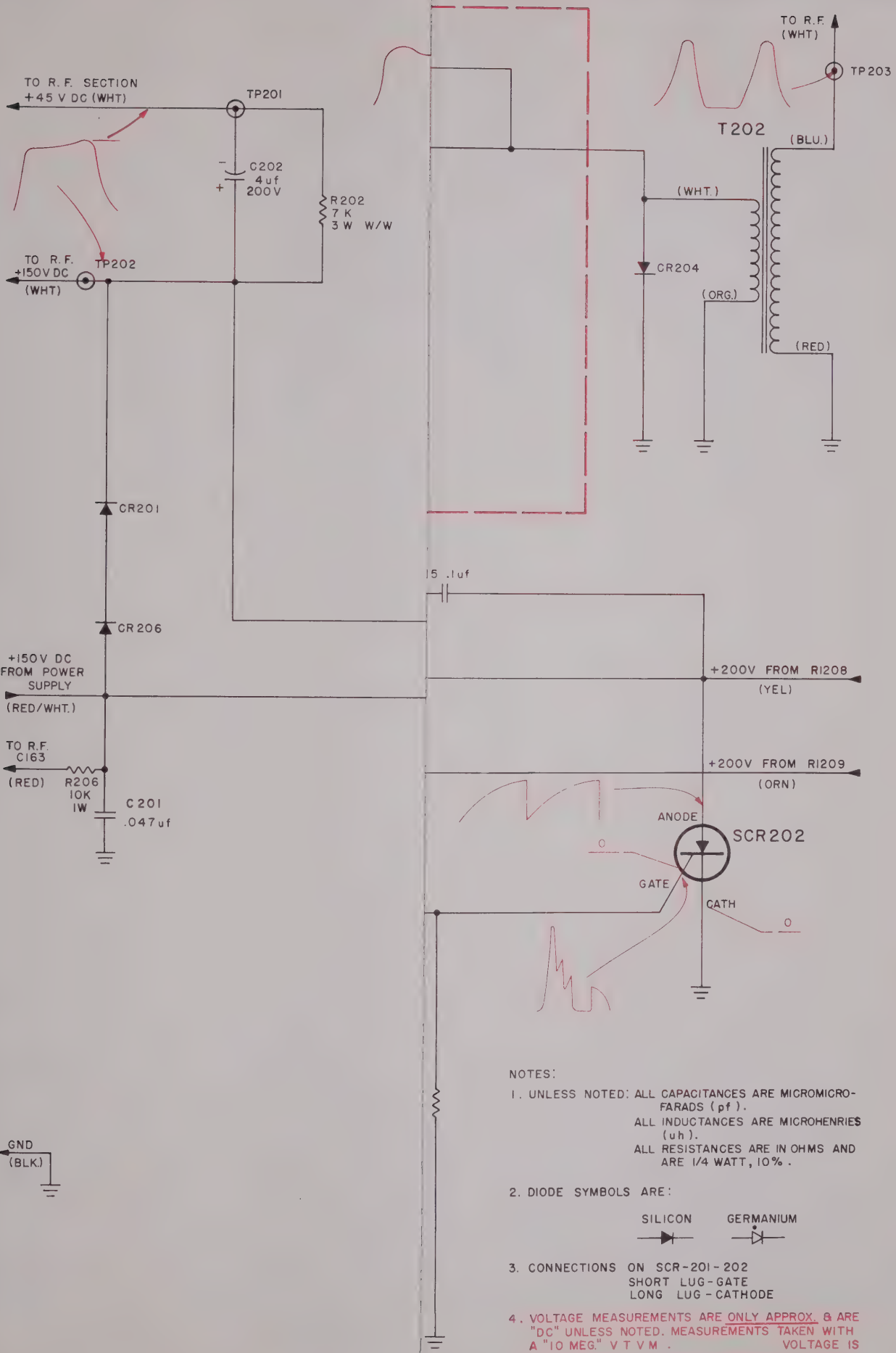


AGC Amp Input, Q-311 Base
AGC @ TP-304 = 0.5 volts
Center Line = 0 volts
Vertical - 1 volt per cm.
Horizontal - 5 microseconds per cm.



Decoder Waveforms
Top - Q-309 Base - 2 volts per cm.
Middle - Q-308 Base - 2 volts per cm.
Bottom - Q-308 Collector - 5 volts per cm.
Horizontal - 5 microseconds per cm.

Figure 7-5A. IF Section Waveforms



NOTES:

1. UNLESS NOTED: ALL CAPACITANCES ARE MICROMICRO-
FARADS (pf).
ALL INDUCTANCES ARE MICROHENRIES
(uh).
ALL RESISTANCES ARE IN OHMS AND
ARE 1/4 WATT, 10%.

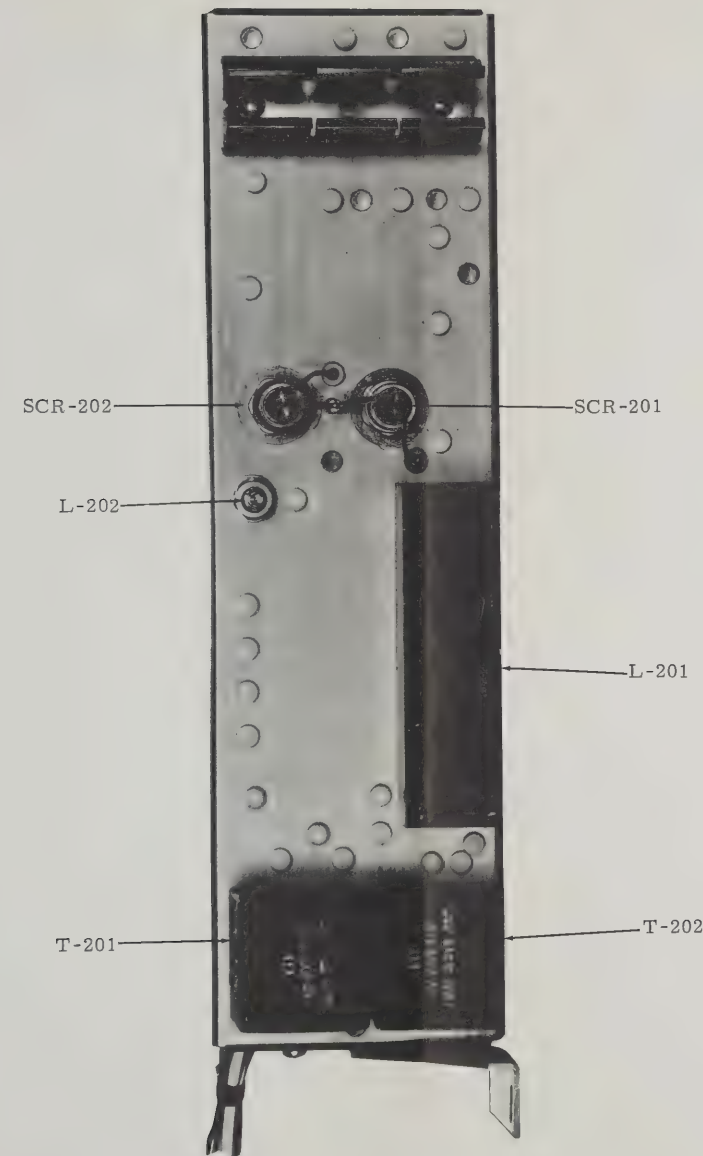
2. DIODE SYMBOLS ARE:

SILICON GERMANIUM

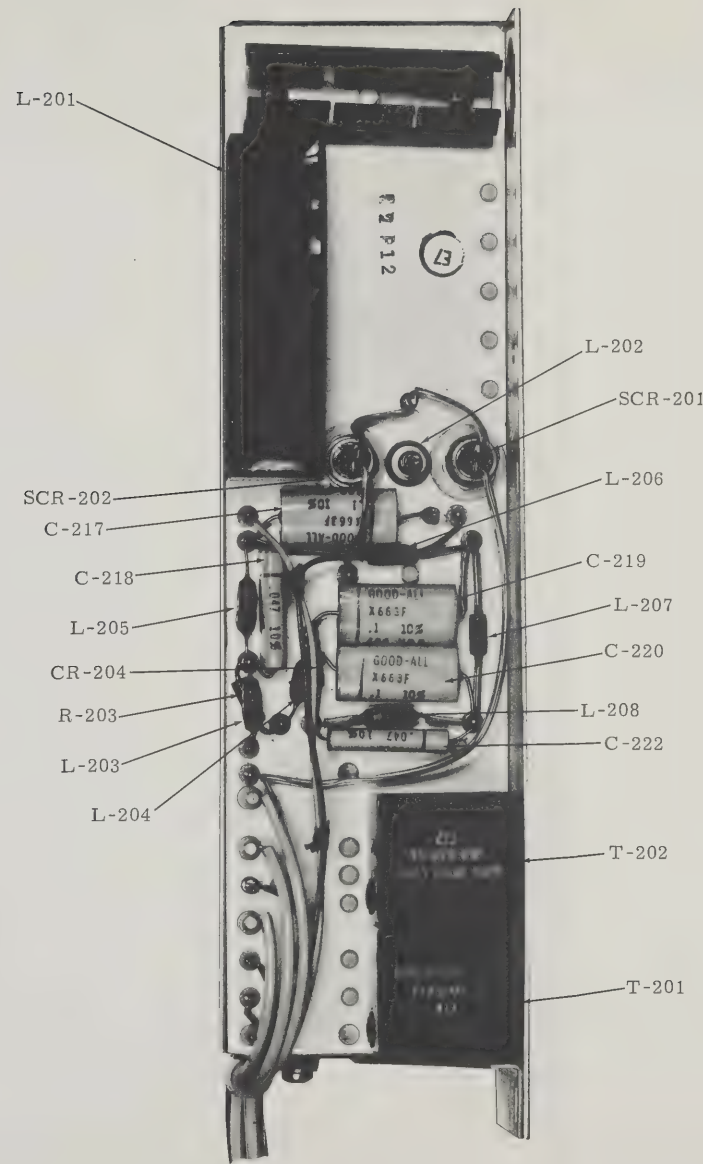
3. CONNECTIONS ON SCR-201-202
SHORT LUG-GATE
LONG LUG-CATHODE

4. VOLTAGE MEASUREMENTS ARE ONLY APPROX. & ARE "DC" UNLESS NOTED. MEASUREMENTS TAKEN WITH A "10 MEG." V T V M . VOLTAGE IS SHOWN ABOVE THE LINE & RESISTANCE BELOW THE LINE.

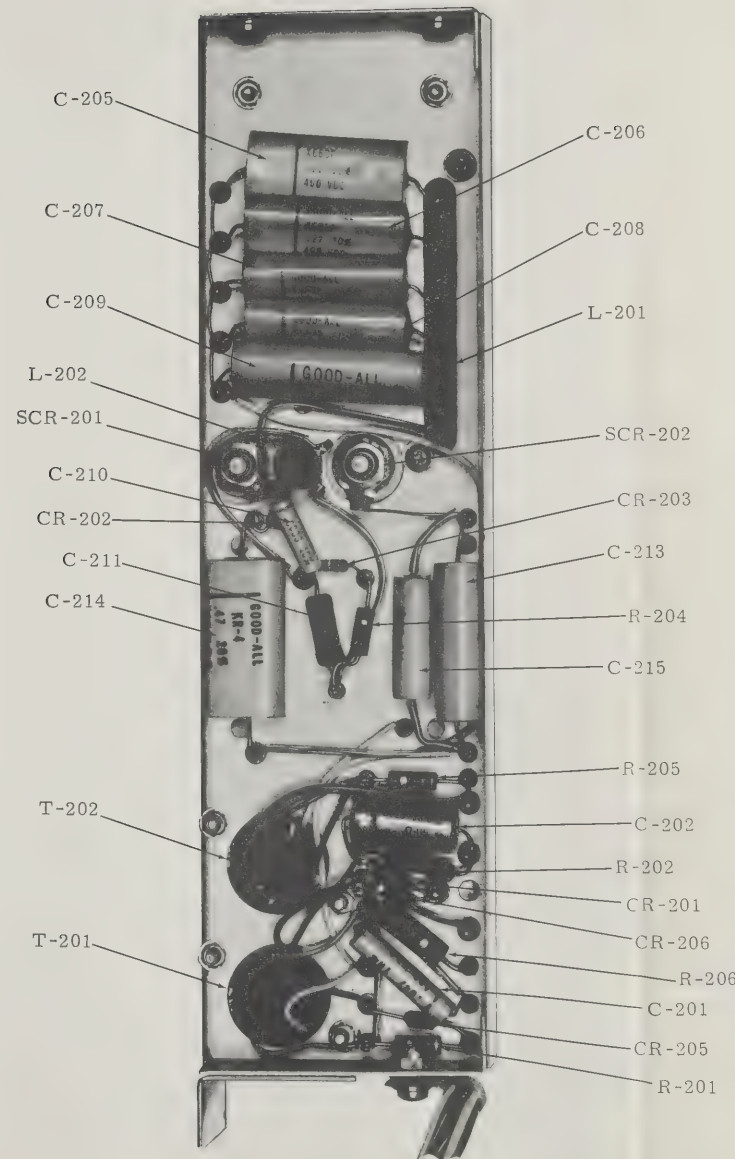
5. (◇) DENOTES VALUE CHANGE. SEE PARTS LIST FOR EARLIER VALUE.



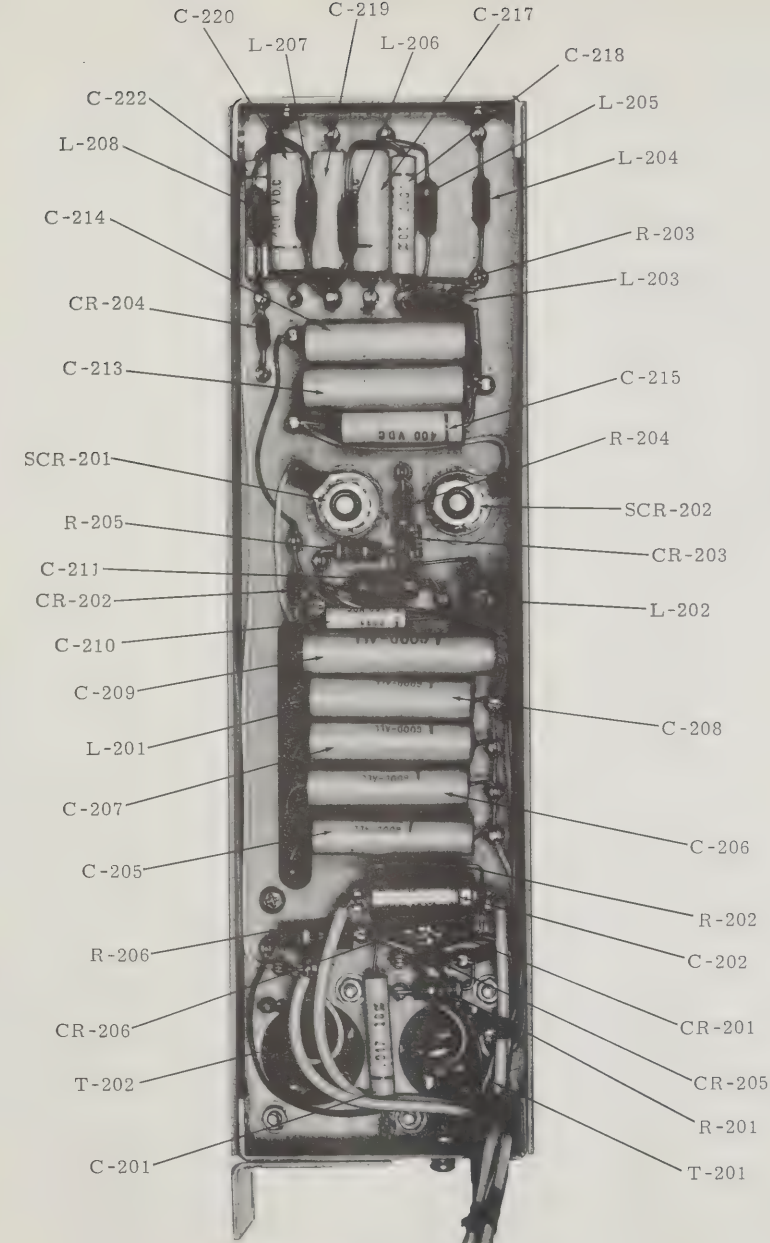
Modulator Section - Top View



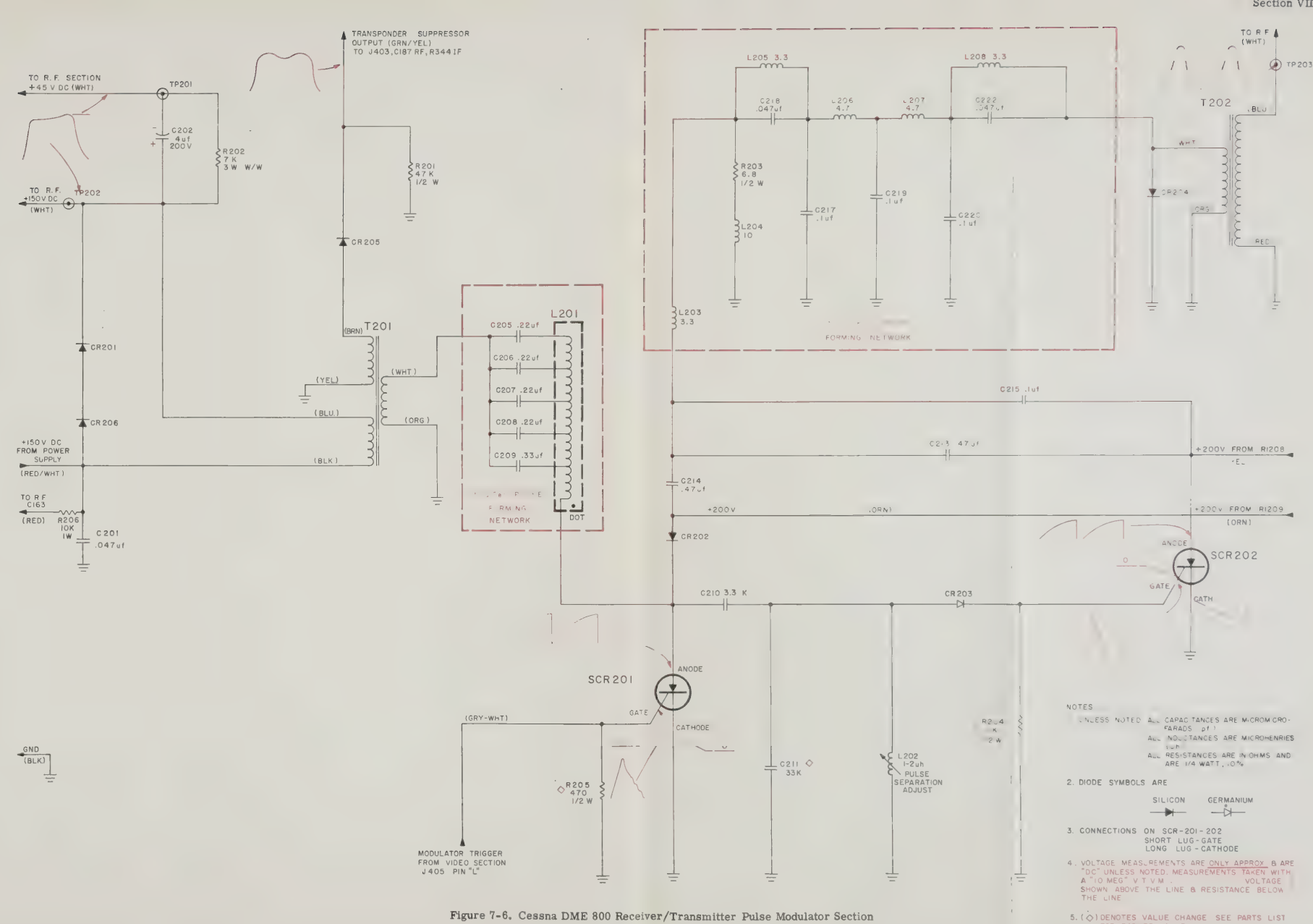
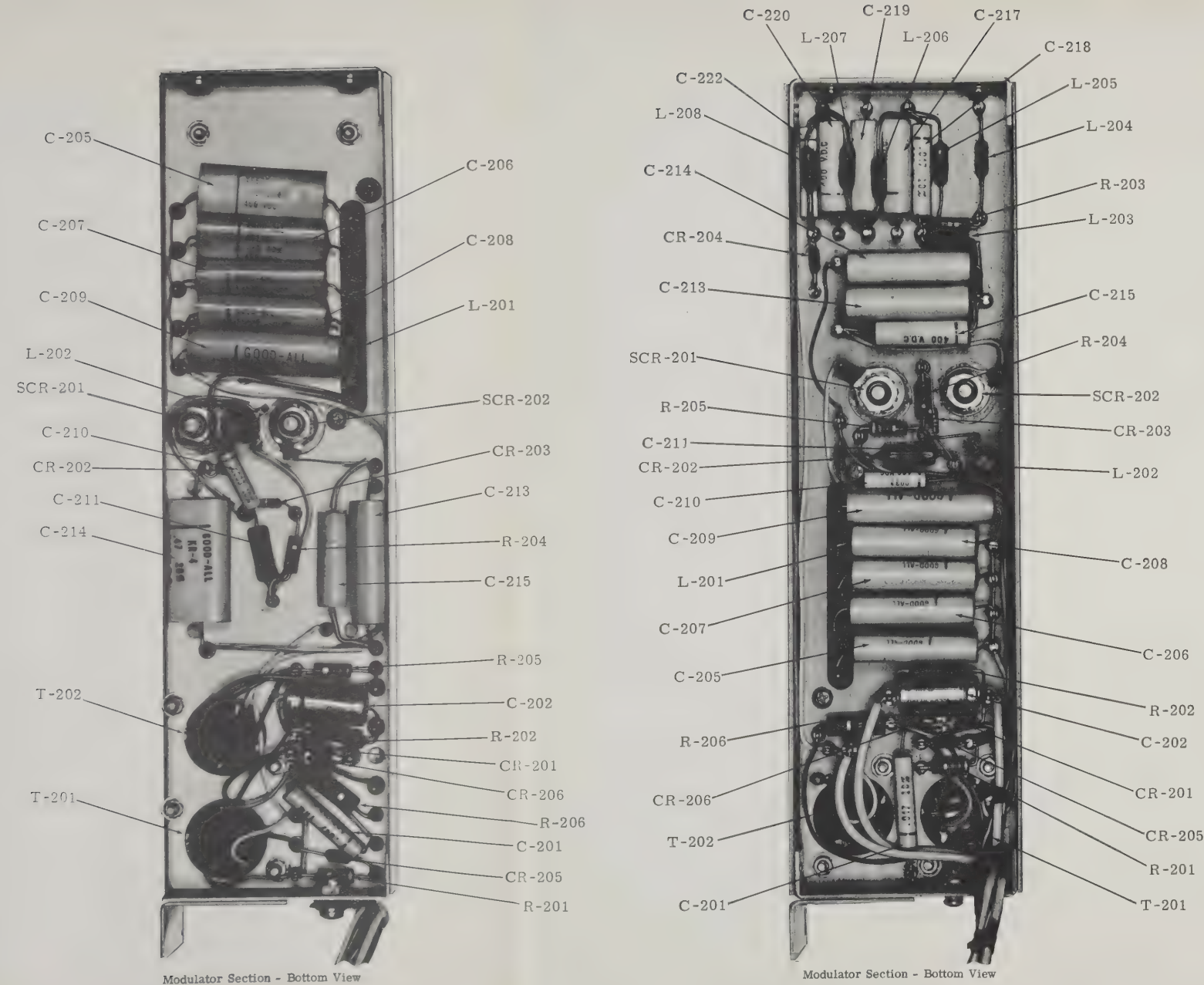
Modulator Section - Top View

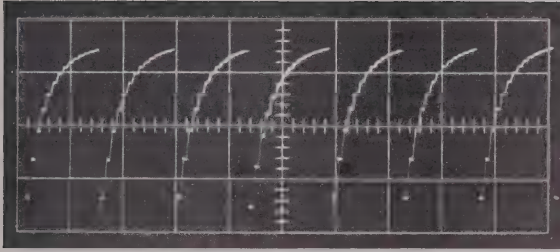


Modulator Section - Bottom View

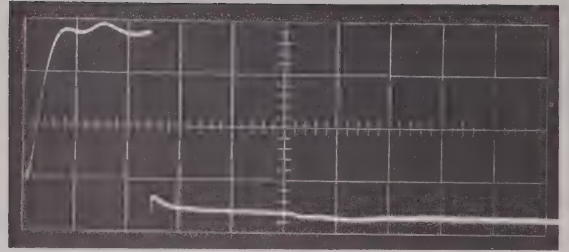


Modulator Section - Bottom View

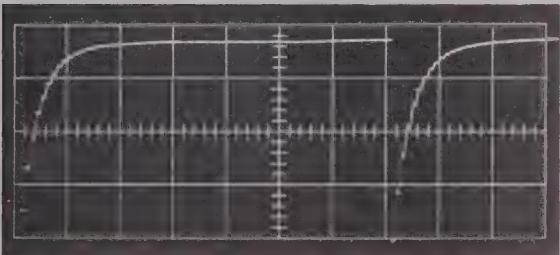




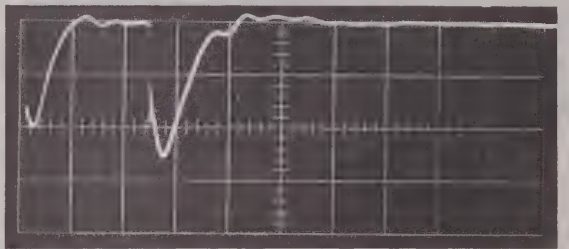
SCR-201 Anode (Search)
 Vertical - 50 volts per cm.
 Scope Sync - Internal Negative
 Horizontal - 5 milliseconds per cm.



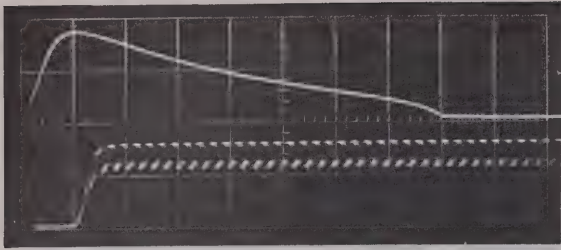
SCR-202 Anode
 Vertical - 50 volts per cm.
 Scope Sync - External from
 Modulator Initiation Pulse
 Horizontal - 5 microseconds per cm.



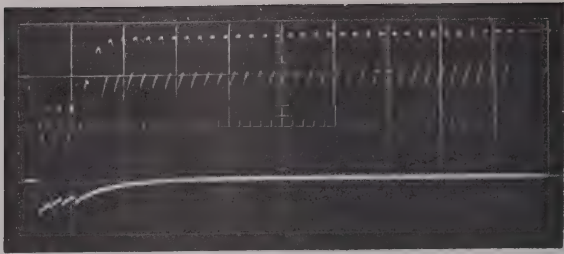
SCR-201 Anode (Track)
 Vertical - 50 volts per cm.
 Scope Sync - Internal Negative
 Horizontal - 5 milliseconds per cm.



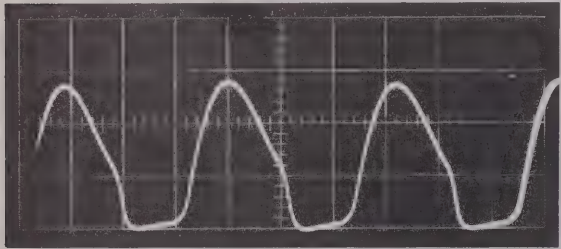
Junction L-203 and L-205
 Top Line = 0 volts
 Vertical - 50 volts per cm.
 Scope Sync - External from J-404
 Horizontal - 5 microseconds per cm.



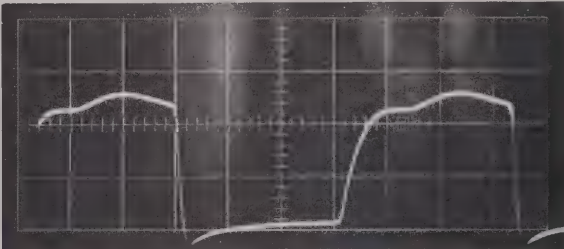
Upper Trace - Q-502 Base 2
Vertical - 2 volts per cm.
Lower Trace - Q503 Collector
Vertical - 10 volts per cm.
Scope Sync - External from Q-502, B₂
Horizontal - 5 microseconds per cm.



Upper Trace - Synchronizing Gate,
C-512 and CR-507 Junction
Vertical - 10 volts per cm.
Lower Trace - CR-507 Anode
Vertical - 10 volts per cm.
Horizontal - 5 microseconds per cm.



Q-507 Collector
Vertical - 5 volts per cm.
Scope Sync - Internal
Horizontal - 0.2 microsecond per cm.



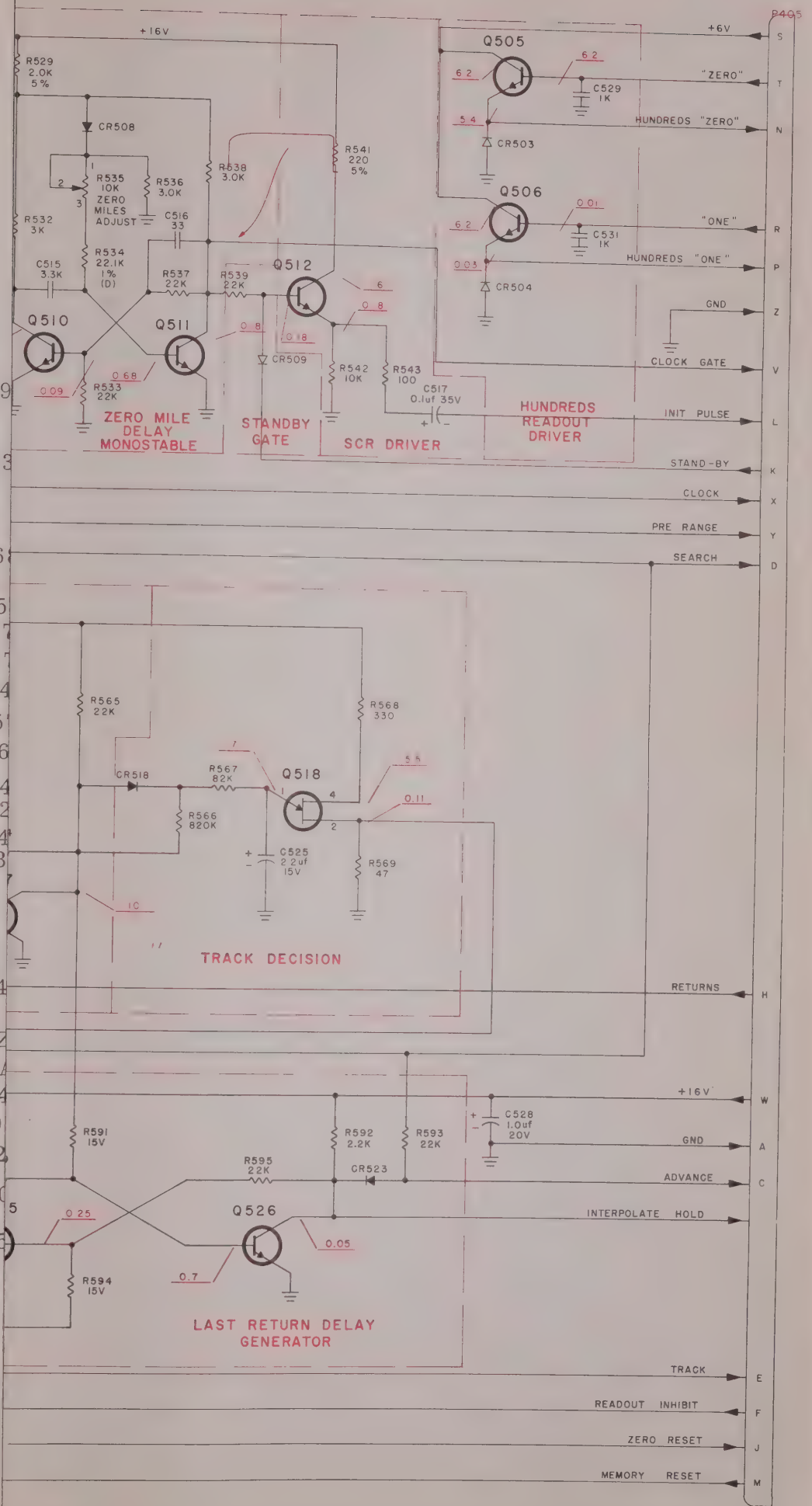
Clock Out, Q-509 Collector
Vertical - 5 volts per cm.
Bottom Line = 0 volts
Horizontal - 0.2 microsecond per cm.

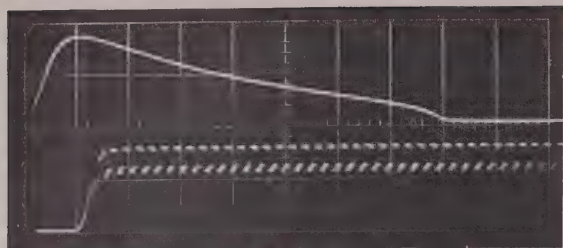
Figure 7-7A. Initiation Board Waveforms (Sheet 2 of 3)

588

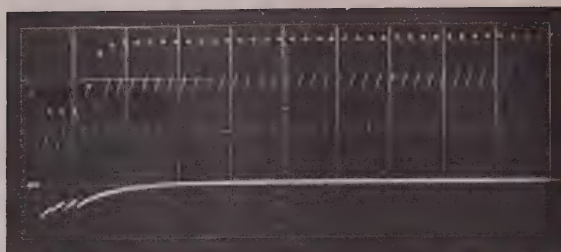
- R-591
- R-573
- R-571
- R-578
- R-579
- R-59
- R-593
- R-575
- R-56
- R-569
- R-5
- R-577
- R-57
- R-574
- R-5
- R-536
- R-54
- R-542
- R-54
- R-548
- R-537
- R-538
- R-539
- R-543
- R-544
- R-533
- R-535
- Miles
- R-534
- R-529
- R-532
- R-50
- R-5
- R-504
- R-505
- R-501

Adj.

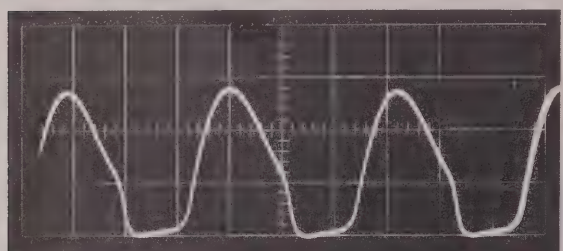




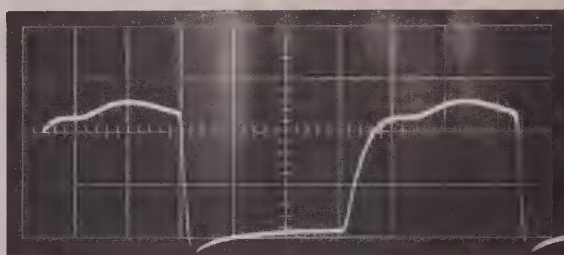
Upper Trace - Q-502 Base 2
Vertical - 2 volts per cm.
Lower Trace - Q503 Collector
Vertical - 10 volts per cm.
Scope Sync - External from Q-502, B₂
Horizontal - 5 microseconds per cm.



Upper Trace - Synchronizing Gate,
C-512 and CR-507 Junction
Vertical - 10 volts per cm.
Lower Trace - CR-507 Anode
Vertical - 10 volts per cm.
Horizontal - 5 microseconds per cm.

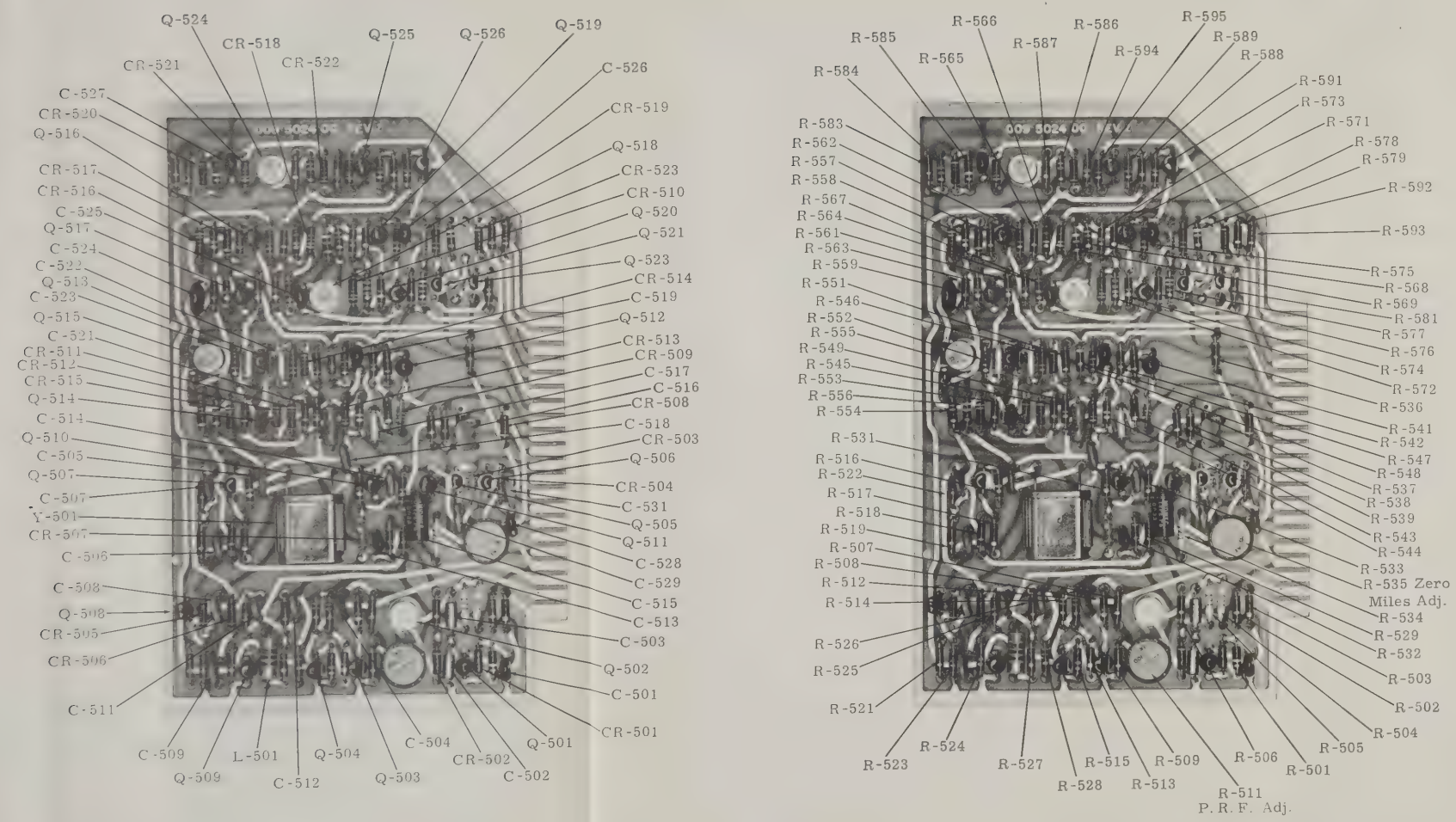


Q-507 Collector
Vertical - 5 volts per cm.
Scope Sync - Internal
Horizontal - 0.2 microsecond per cm.



Clock Out, Q-509 Collector
Vertical - 5 volts per cm.
Bottom Line = 0 volts
Horizontal - 0.2 microsecond per cm.

Figure 7-7A. Initiation Board Waveforms (Sheet 2 of 3)



Initiation Circuit Board

Initiation Circuit Board - Resistors

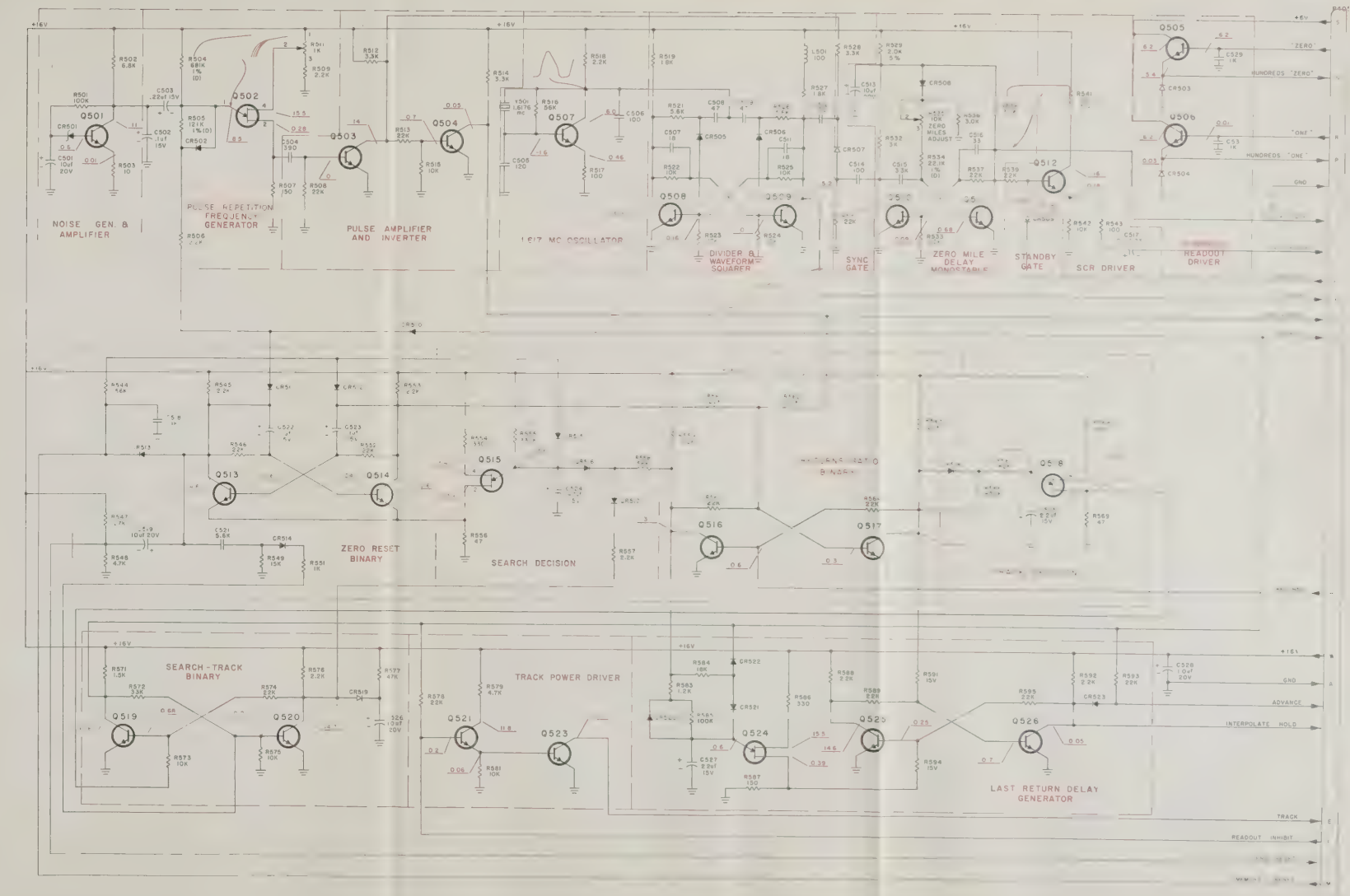
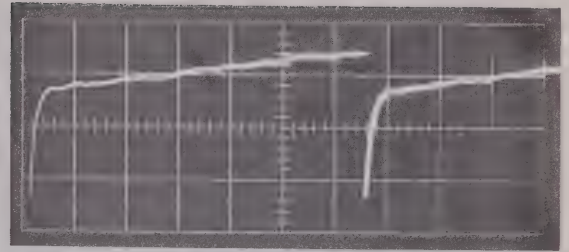


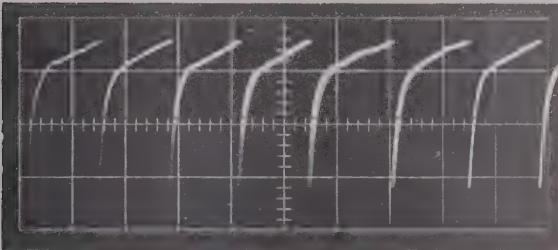
Figure 7-7. Cessna DME 800 Receiver/Transmitter Initiation Circuit Board



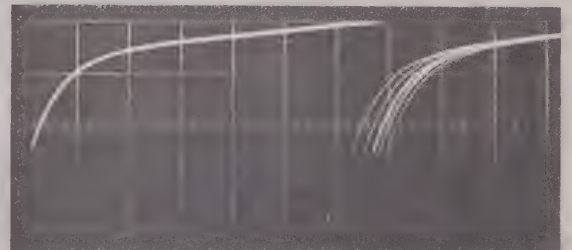
Q-501 Collector, Memory
Reset Line Grounded
Vertical - 0.1 volt per cm, AC
coupled
Horizontal - 20 milliseconds per cm.



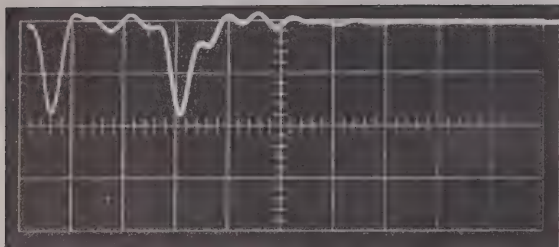
Q-502 Emitter (Track)
Vertical - 2 volts per cm, AC
coupled
Horizontal - 5 microseconds per cm.



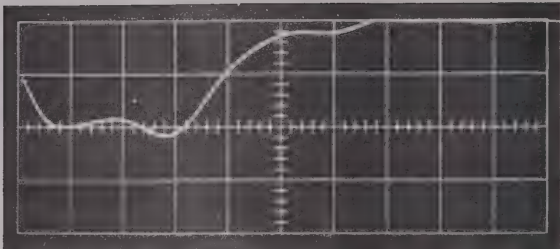
Q-502 Emitter (Search)
Vertical - 2 volts per cm, AC
coupled
Horizontal - 5 milliseconds per cm.



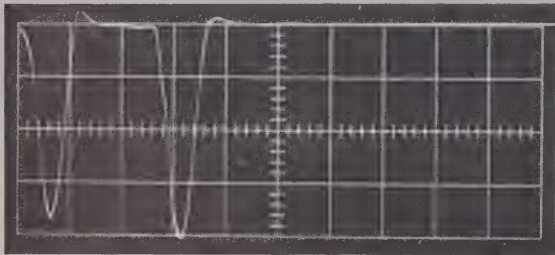
Q-502 Emitter (Track)
Vertical - 2 volts per cm.
Horizontal - 1 millisecond per cm.



Junction L-207 and L-208
Top Line = 0 volts
Vertical - 50 volts per cm.
Scope Sync - External from J-404
Horizontal - 5 microseconds per cm.

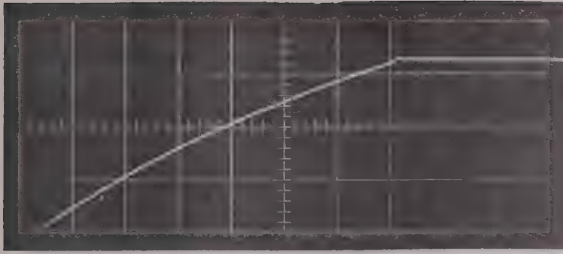


T-201 Primary
Top Line = 0 volts
Vertical - 50 volts per cm.
Scope Sync - Internal Negative
Horizontal - 5 microseconds per cm.

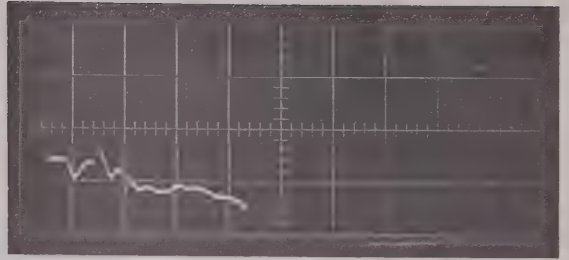


T-202 Primary
Top Line = 0 volts
Vertical - 20 volts per cm.
Scope Sync - External from J-404
Horizontal - 5 microseconds per cm.

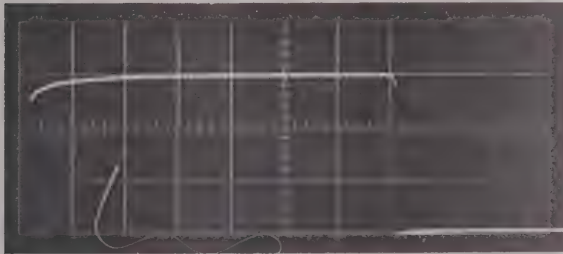
Figure 7-6A. Modulator Waveforms (Sheet 2 of 2)



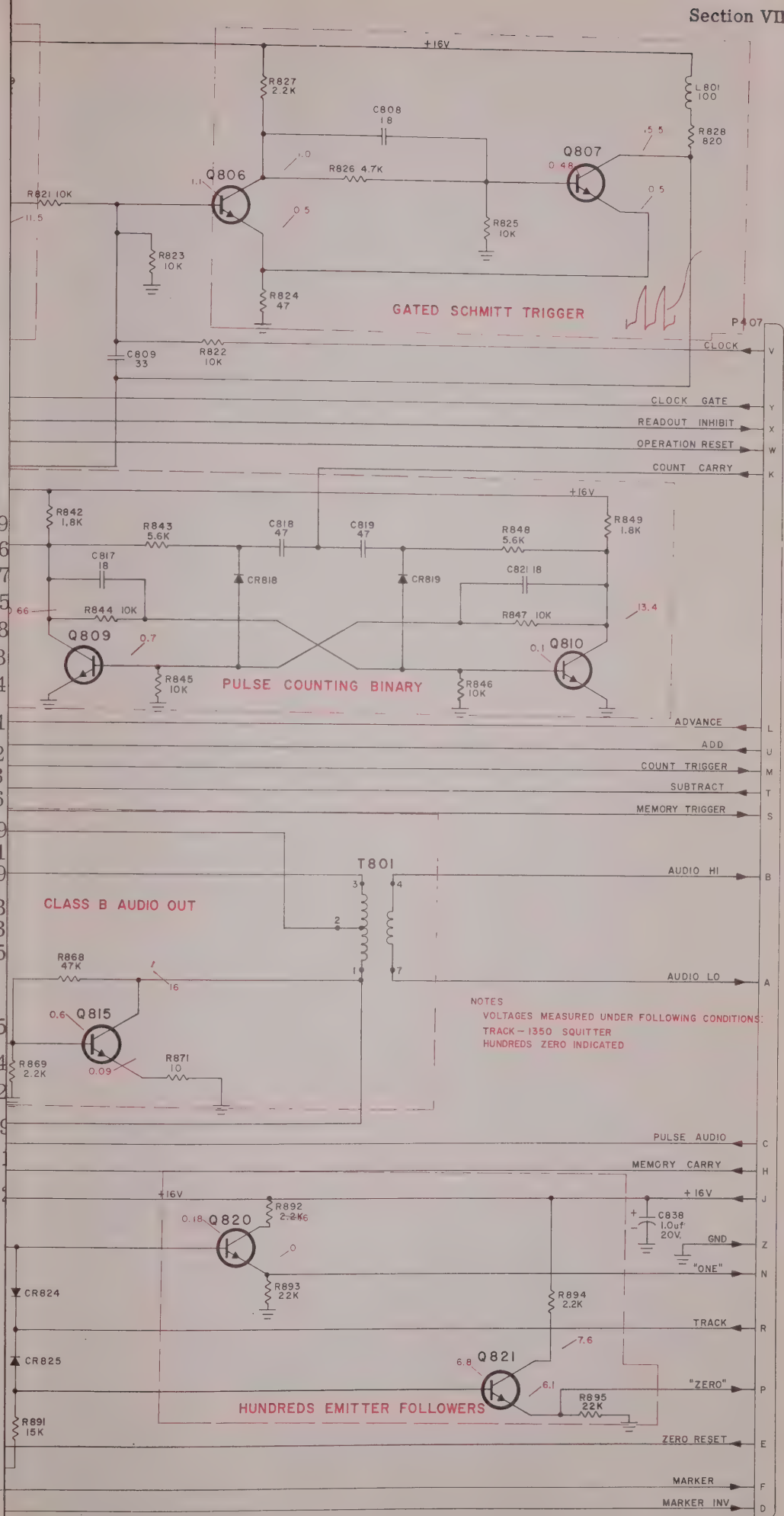
Q-511 Base
 Vertical - 2 volts per cm, DC
 coupled. First line from
 top = 0 volts
 Scope Sync - Internal
 Horizontal - 10 microseconds per cm.

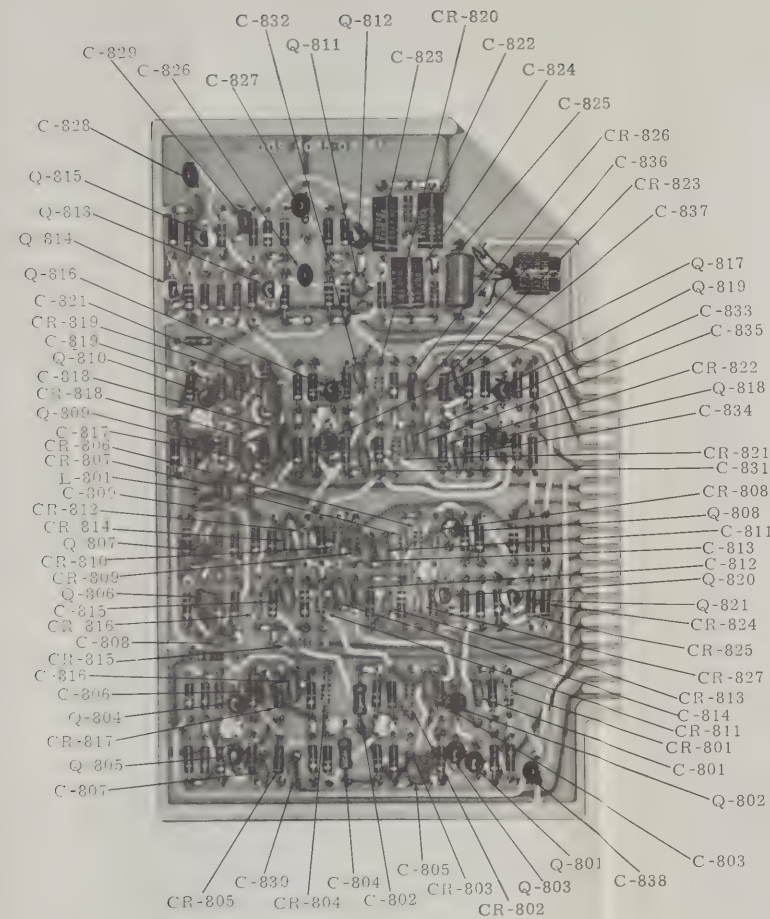


Initiation Board, Pin L
 Initiation Pulse to Pulse Modulator
 Vertical - 1 volt per cm, DC
 coupled. Bottom line = 0 volts
 Scope Sync - Internal
 Horizontal - 10 microseconds per cm.

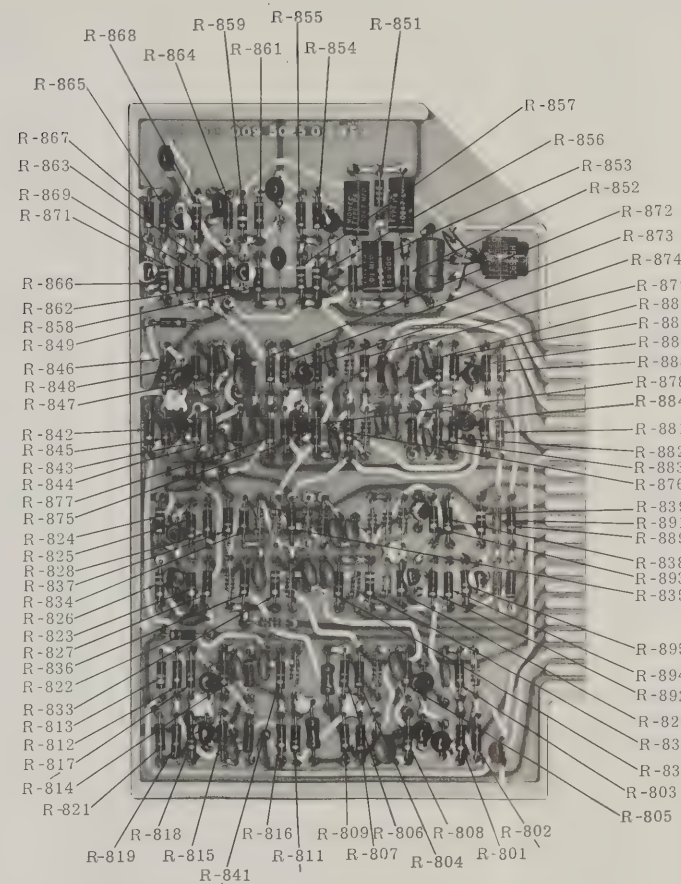


Clock Gate Out, Q-511 Collector
 Vertical - 2 volts per cm, DC
 coupled. Bottom line = 0 volts
 Scope Sync - Internal
 Horizontal - 10 microseconds per cm.





Operation Circuit Board



Operation Circuit Board - Resistors

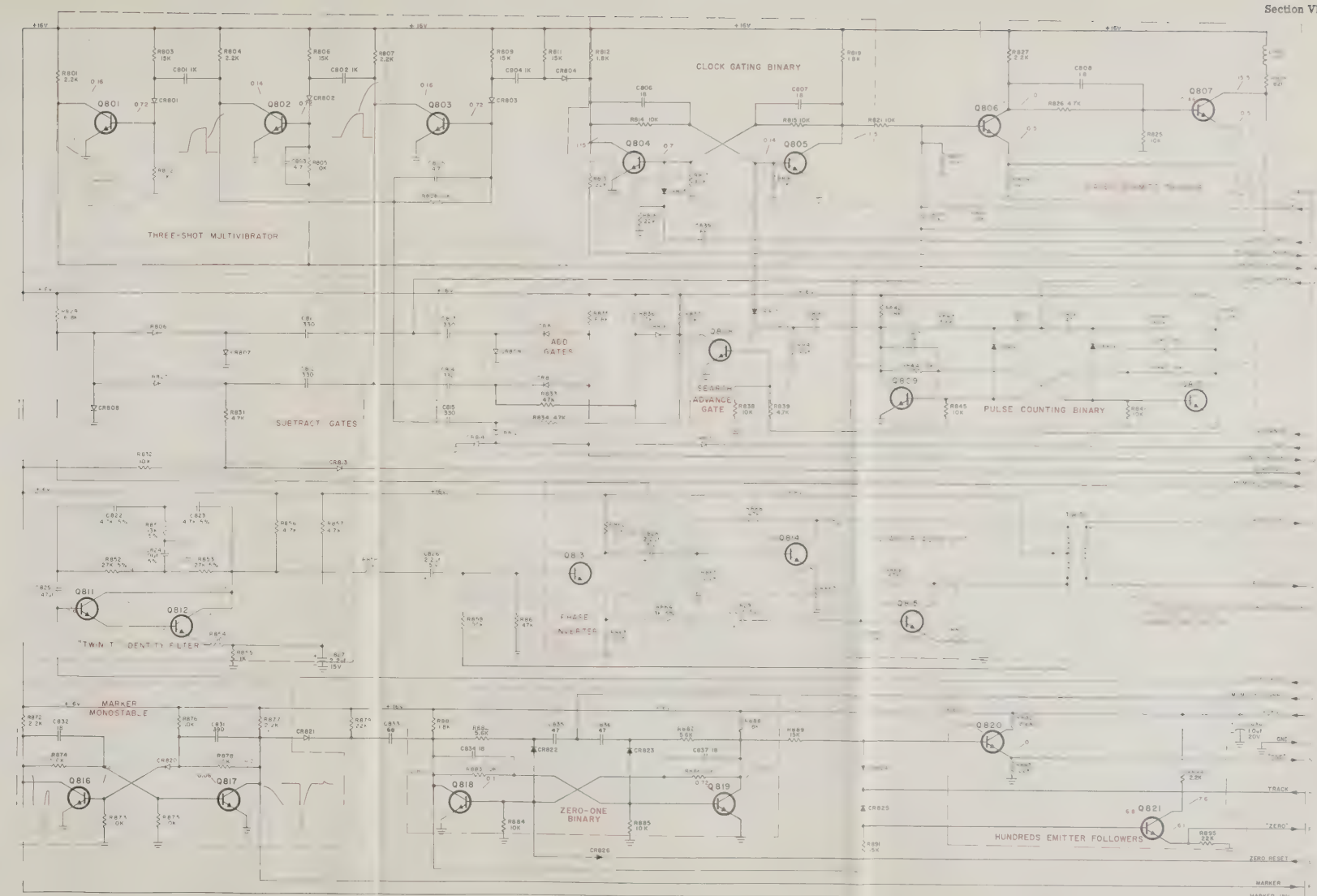
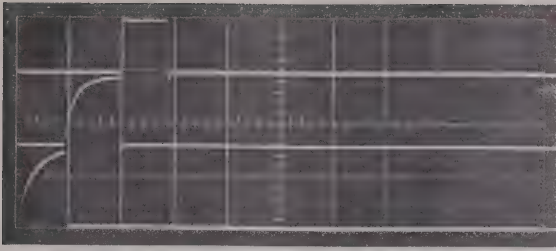
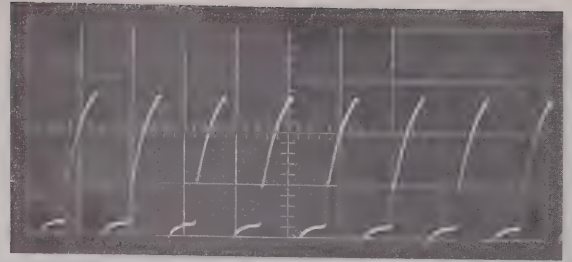


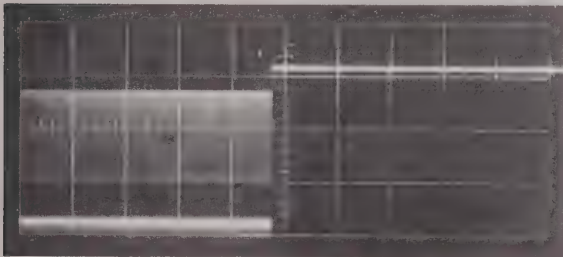
Figure 7-8. Cessna DME 800 Receiver/Transmitter Operation Circuit Board



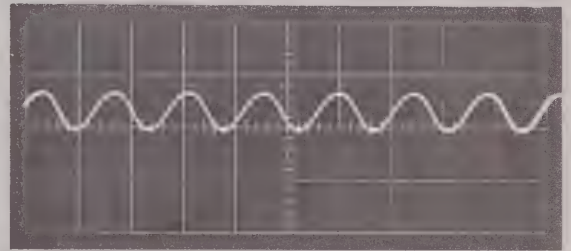
Three-Shot Multivibrator
 Upper Trace - Q-801 Collector
 Middle Trace - Q-802 Collector
 Lower Trace - Q-803 Collector
 Vertical - 10 volts per cm.
 Scope Sync - External from Q-804
 Collector
 Horizontal - 10 volts per cm.



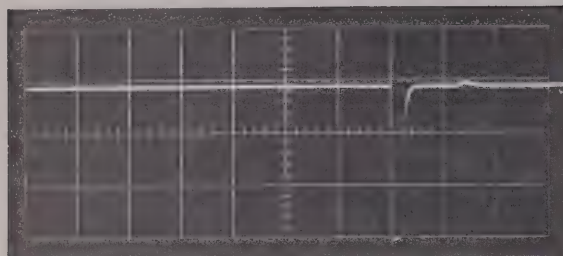
Gated Schmitt Output, Q-807 Collector
 Vertical - 5 volts per cm.
 Bottom Line = 0 volts
 Scope Sync - Internal
 Horizontal - 1 microsecond per cm.



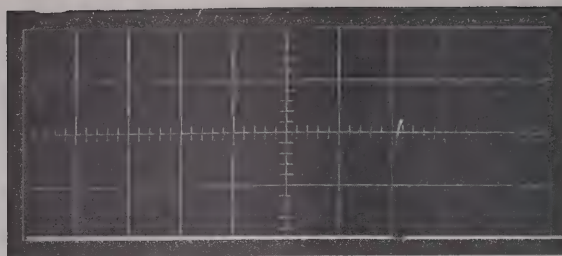
Gated Schmitt Output, Q-807 Collector
 Vertical - 5 volts per cm.
 Bottom Line = 0 volts
 Scope Sync - Internal
 Horizontal - 0.5 milliseconds per cm.



Twin T Output, Q-811 and Q-812
 Collectors
 Vertical - 5 volts per cm.
 Bottom Line = 0 volts
 DC coupled 1350 prf Squitter, no returns
 Horizontal - 0.5 milliseconds per cm.



Marker Out
Operation Board, Pin F, Q-817
Collector
Vertical - 5 volts per cm.
Bottom Line = 0 volts
Scope Sync - External from Initiation
Board Pin L
Indicated Distance - zero miles
No Squitter
Horizontal - 10 microseconds per cm.



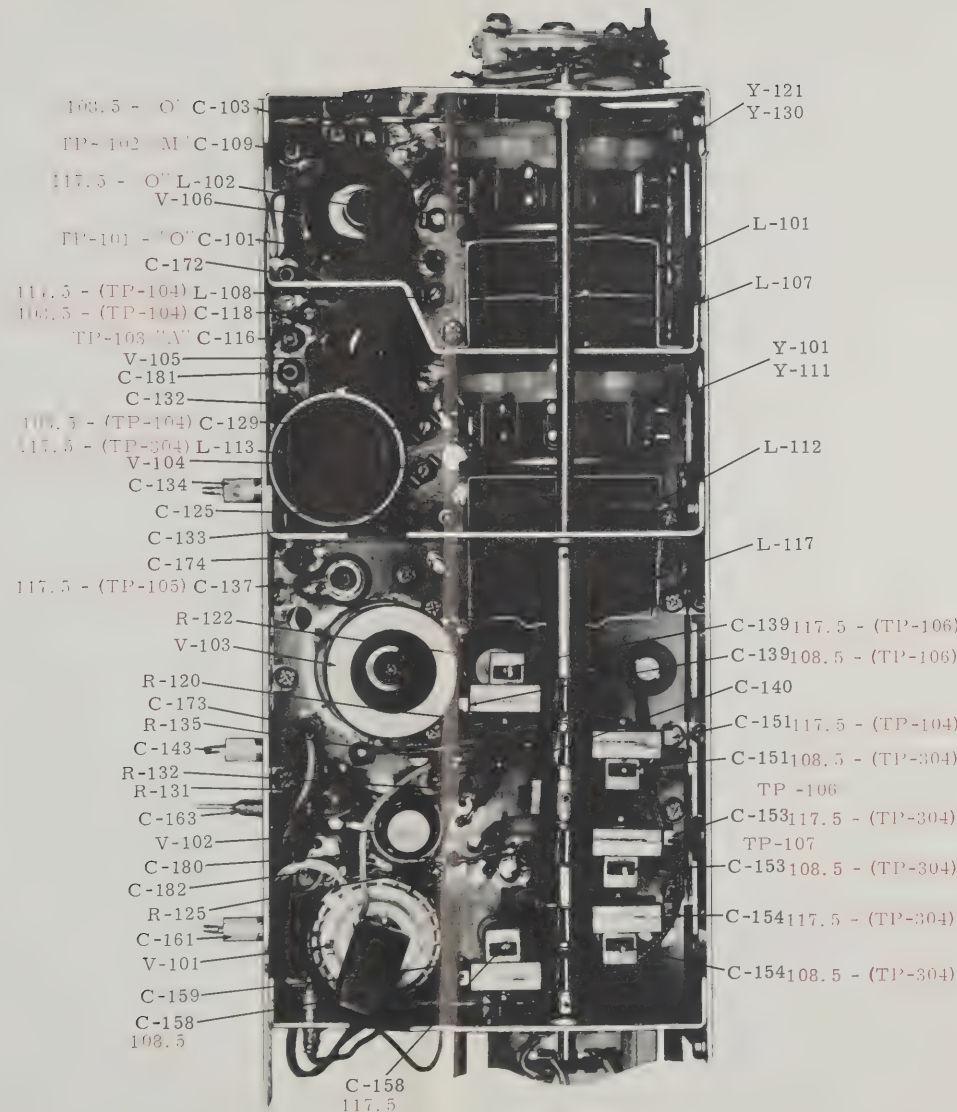
Marker Inverted Out
Operation Board Pin D, Q-816 Collector
Vertical - 5 volts per cm.
Bottom Line = 0 volts
Scope Sync - External from Initiation
Board Pin L
Indicated Distance - zero miles
No Squitter
Horizontal - 10 microseconds per cm.

Figure 7-8A. Operation Board Waveforms (Sheet 2 of 2)

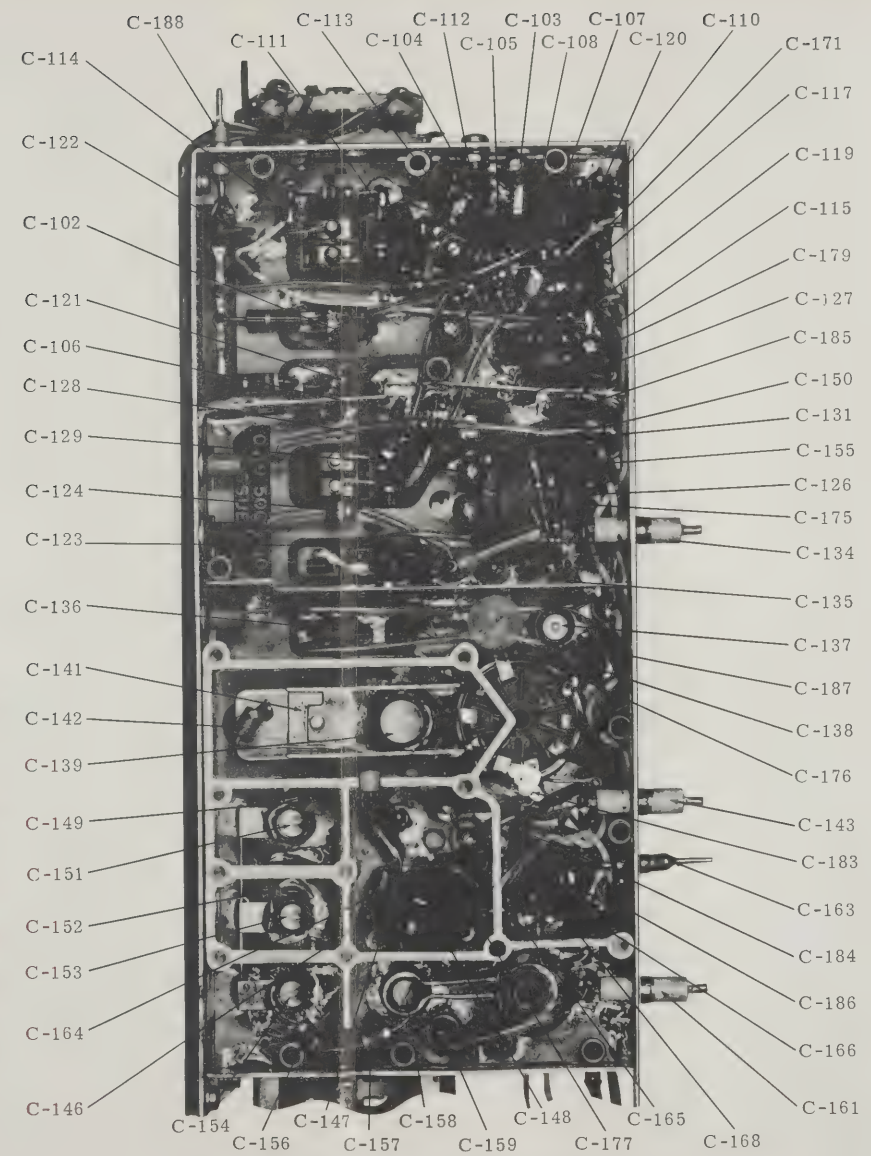


ONLY APPROX. AND ARE "DC" UNLESS NOTED.
"10 MEG." VTVM.
DISTANCE BELOW THE LINE.

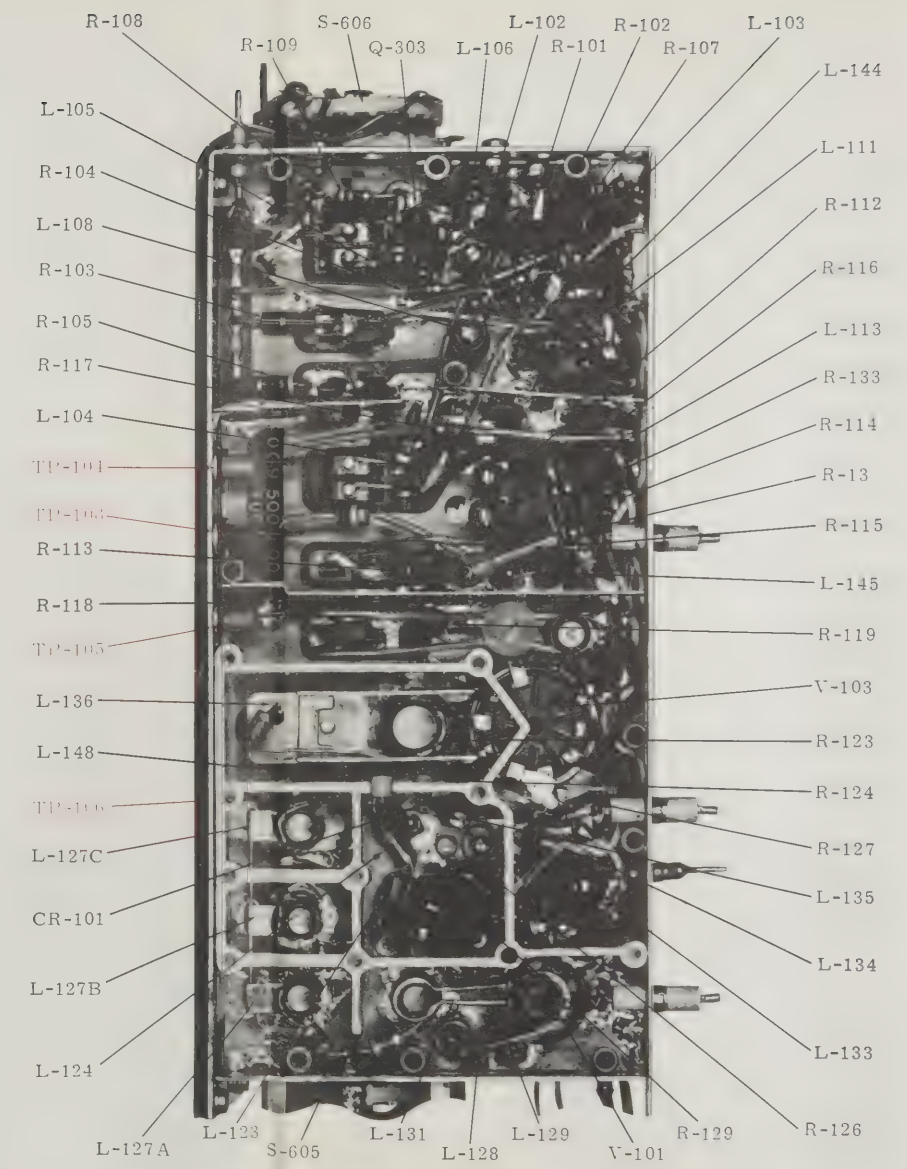
SEE PARTS LIST FOR EARLIER VALUE.



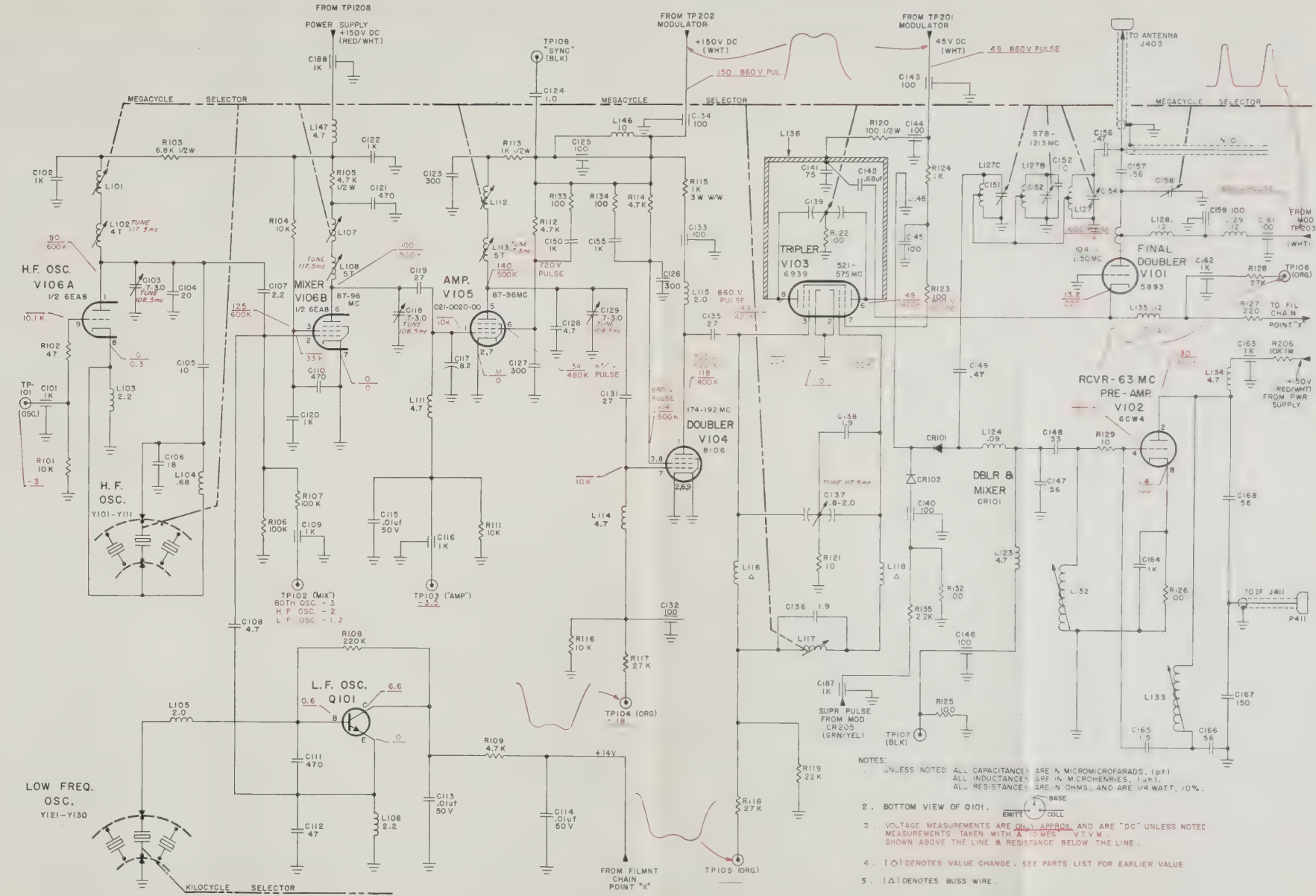
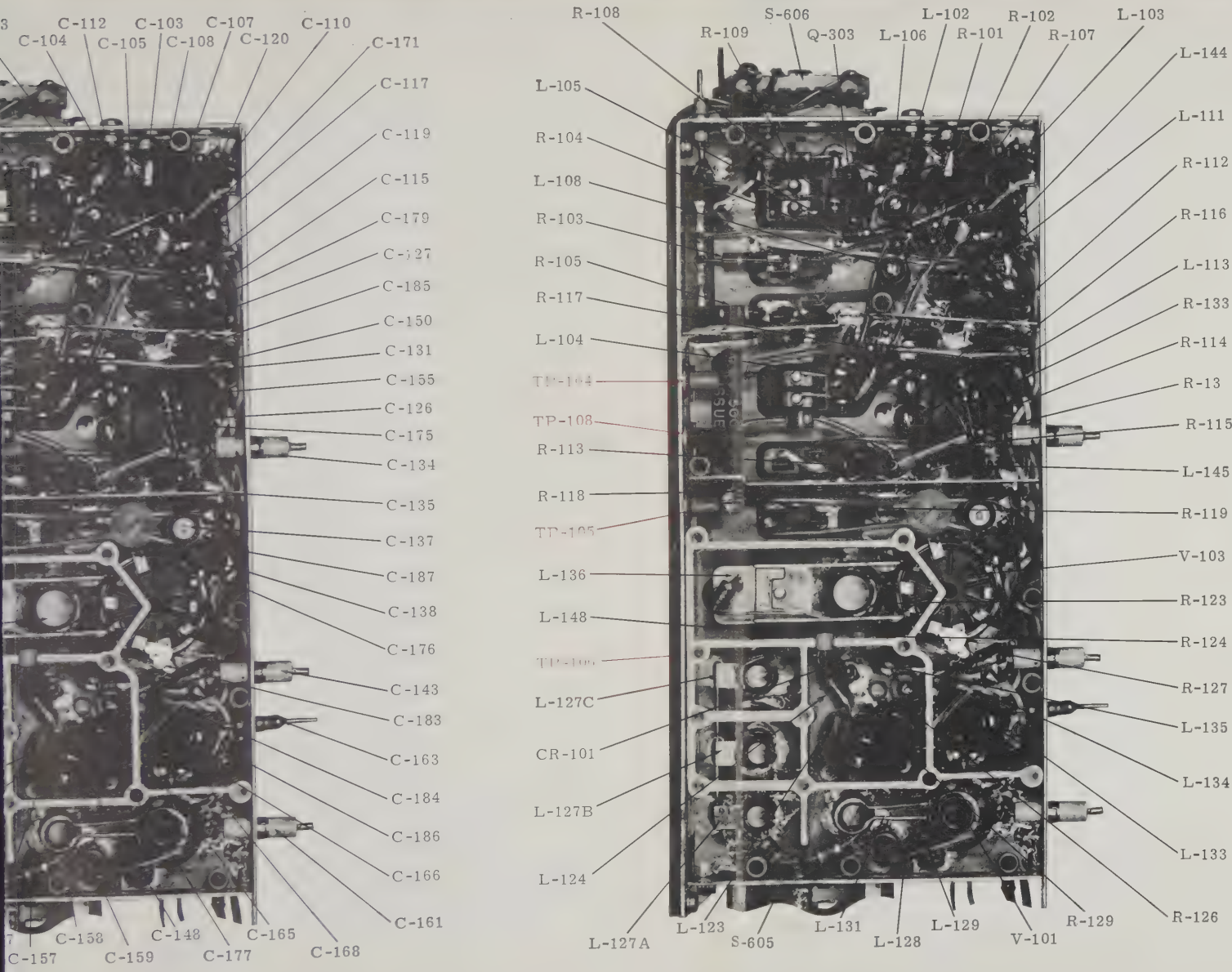
RF Section Top View



RF Section Capacitors Bottom View

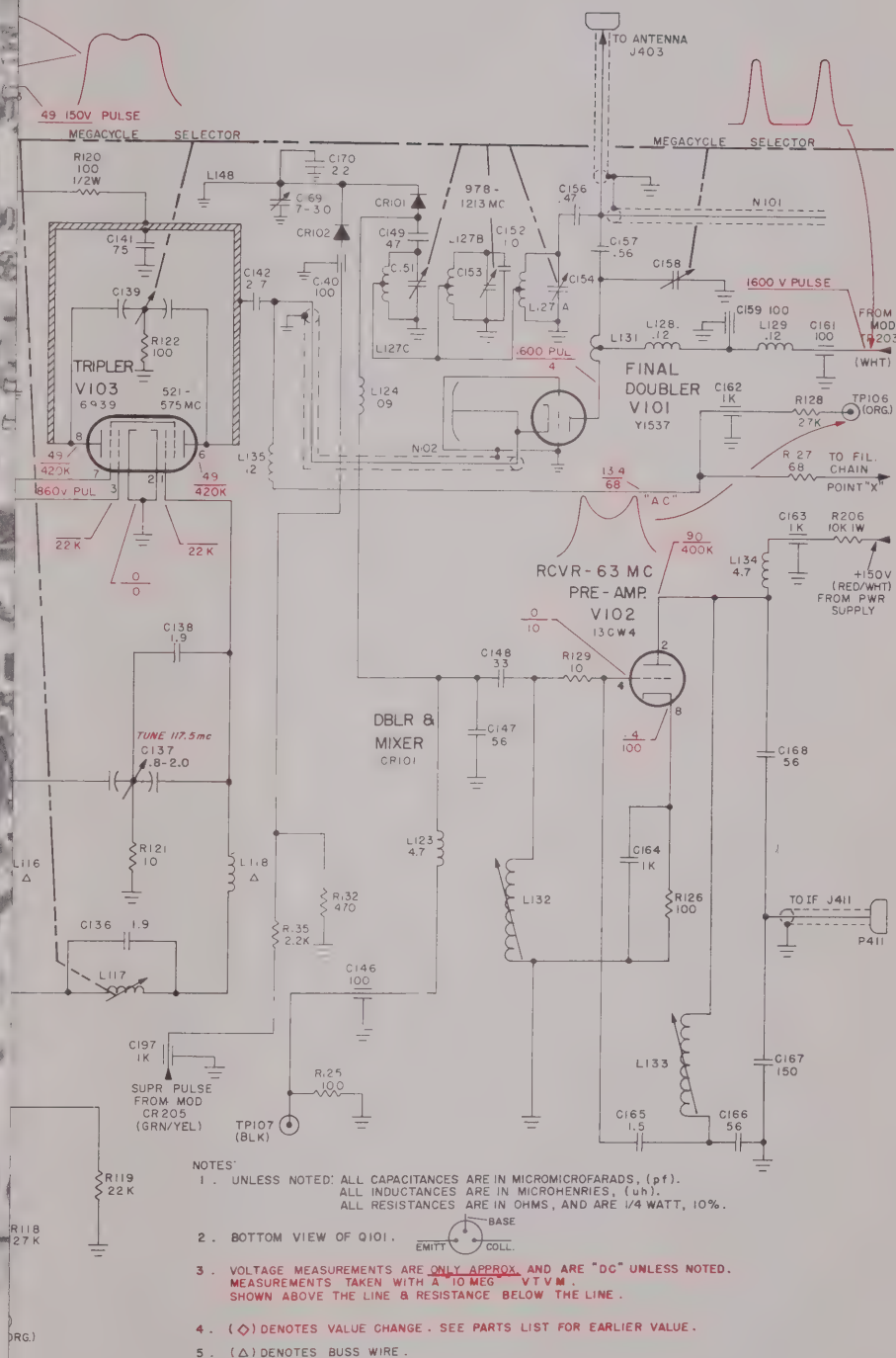


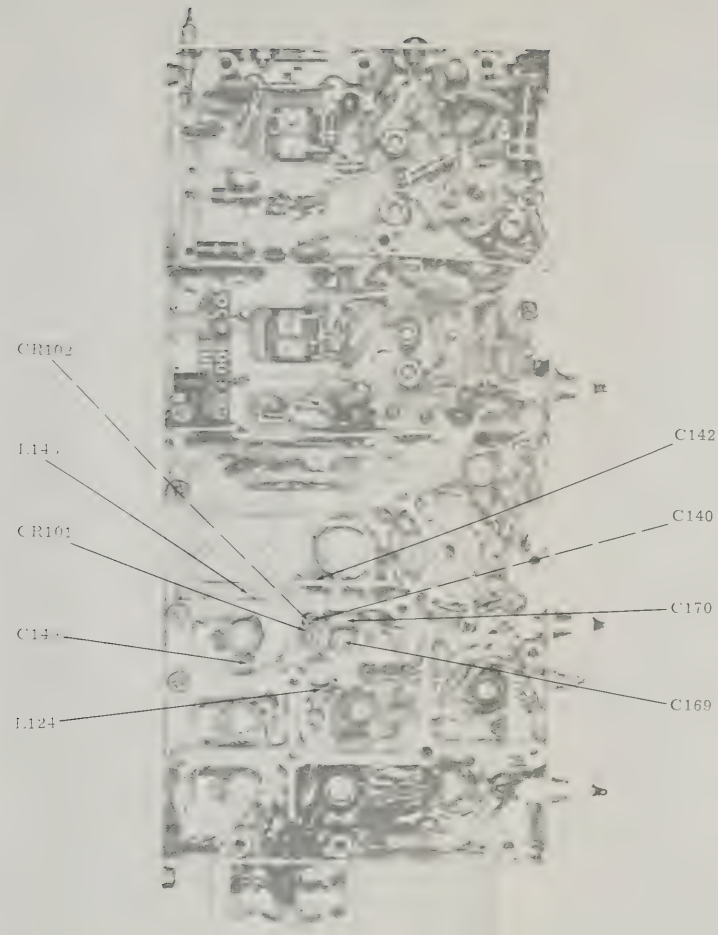
RF Section Bottom View



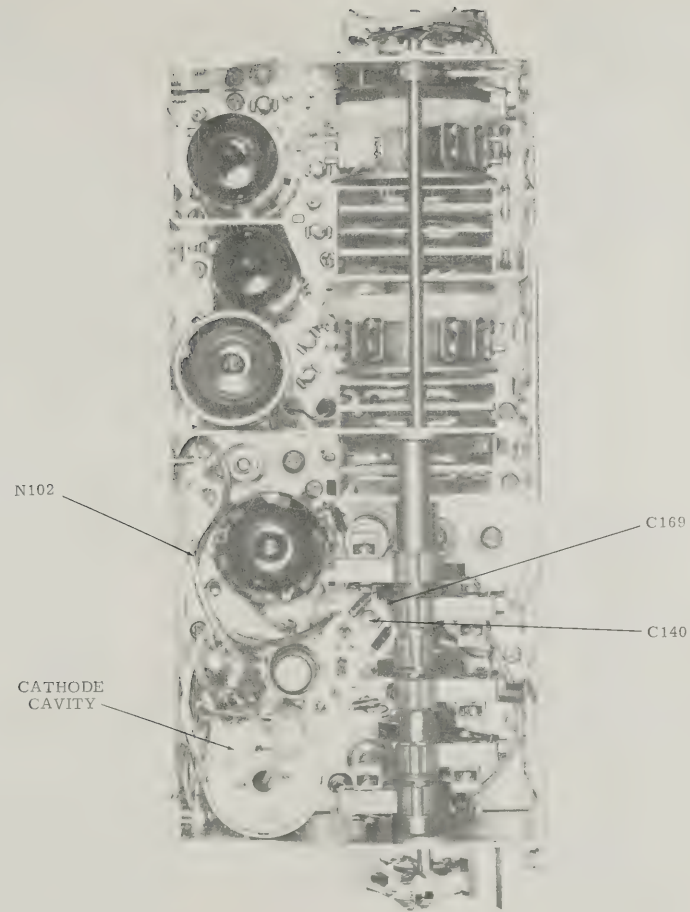
- NOTES:
- UNLESS NOTED ALL CAPACITANCES ARE IN MICROMICROFARADS. (PF)
 - ALL INDUCTANCES ARE IN MICROHENRIES. (UH)
 - ALL RESISTANCES ARE IN OHMS, AND ARE 1/4 WATT, 10%.
 - (O) DENOTES VALUE CHANGE. SEE PARTS LIST FOR EARLIER VALUE
 - (Δ) DENOTES BUSS WIRE.

Figure 7-9. Cessna DME 800 Receiver/Transmitter R-F Section





Cessna DME 800 RF Section, Bottom View High Power Version



Cessna DME 800 RF Section, Top View High Power Version

CESSNA DME 800 UNITS 1400 AND ON

Figure 7-9A. Cessna DME 800 Receiver/Transmitter RF Section High Power Version

Q-620

C-621

CR-629

CR-619

CR-626

CR-623

Q-617

Q-609

Q-618

CR-624

CR-620

C-615

C-616

C-612

CR-610

Q-607

CR-621

Q-608

CR-613

CR-609

C-611

C-629

CR-607

CR-603

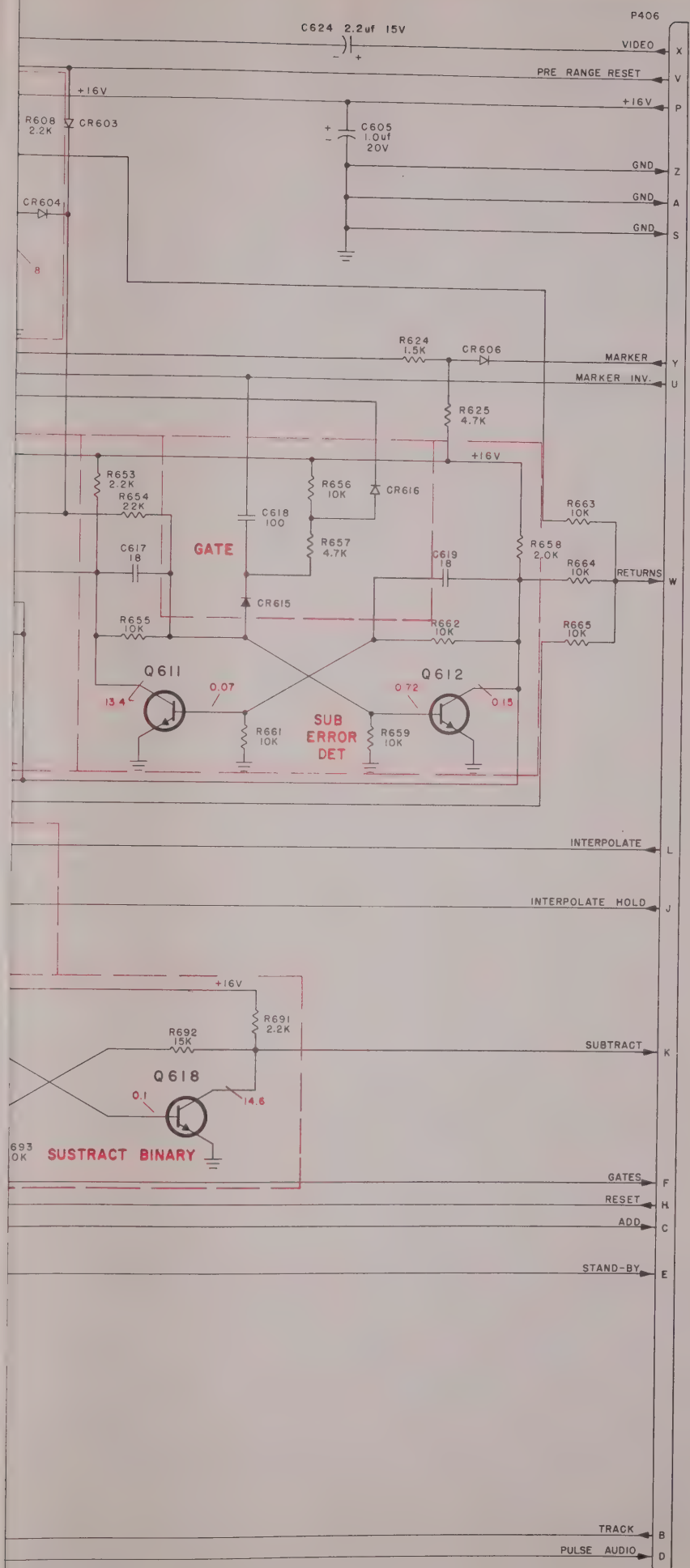
C-624

CR-602

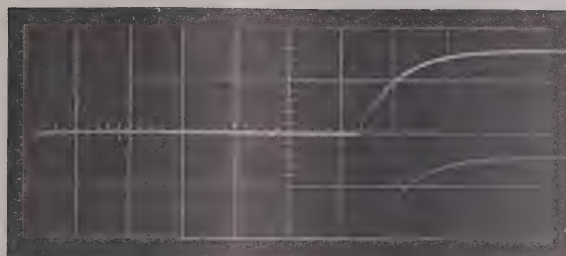
C-602

Q-601

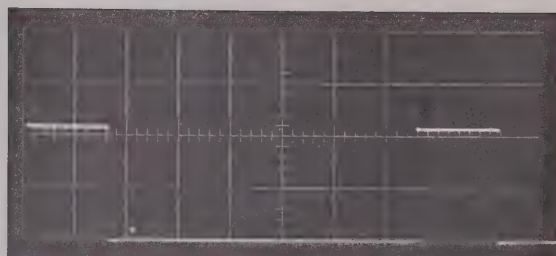
C-601



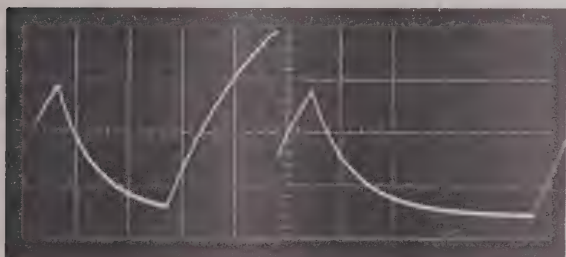
te Circuit Board



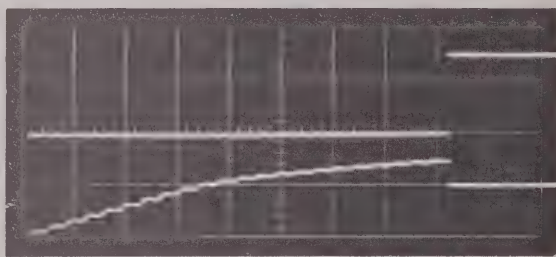
Upper Trace - Pregate Monostable
Q-602 Collector
Vertical - 10 volts per cm.
Center Line = 0 volts
Lower Trace - Postgate Monostable
Q-604 Collector
Vertical - 10 volts per cm.
Bottom Line = 0 volts
Scope Sync - External from TP-302
Horizontal - 2 microseconds per cm.



Pulse Stretcher, Q-619 Collector
Vertical - 5 volts per cm.
Bottom Line = 0 volts
1350 prf Squitter, no returns
Scope Sync - Internal
Horizontal - 100 microseconds per cm.

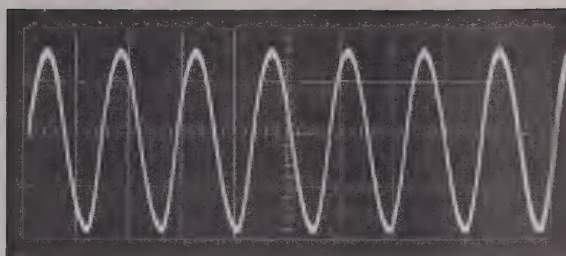


Add Error Integrator, Q-609
Emitter
Vertical - 2 volts per cm.
Bottom Line = 0 volts
T-10B simulating 600 KTS
Horizontal - 0.1 seconds per cm.



Standby Schmitt
Upper Trace - Q-622 Collector
Vertical - 10 volts per cm.
Center Line = 0 volts
Lower Trace - Q-621 Collector
Vertical - 1 volt per cm.
Bottom Line = 0 volts
Both traces chopped, 1350
prf Squitter, no returns
Scope Sync - External
Horizontal - 2 milliseconds per cm.

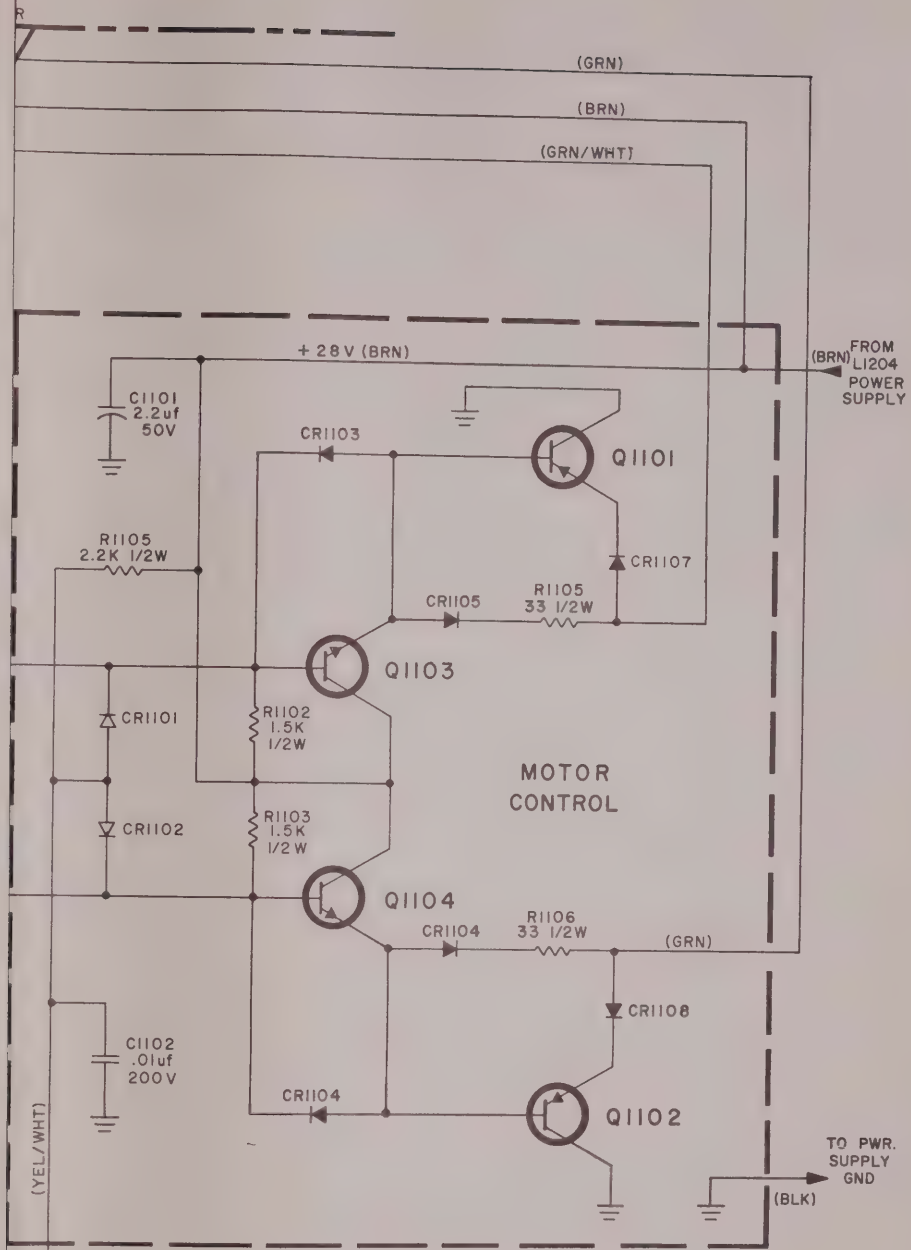
Figure 7-10A. Gate Circuit Waveforms (Sheet 1 of 2)



Gate Board, Pin D
Pulse Audio Out
Vertical - 50 millivolts per cm, AC
coupled. Center line approxi-
mately 2.3vdc
Scope Sync - Internal
1350 prf Squitter, no return
Horizontal - 0.5 millisecond per cm.

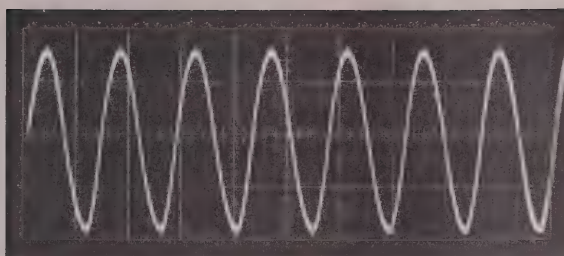
Figure 7-10A. Gate Circuit Waveforms (Sheet 2 of 2)

04
1102
02
1101
03



TO VIDEO
SECTION
MEMORY
RESET

- (BRN/WHT) → TO PIN "G"
 - (BRN) → TO PIN "H"
 - (GRN) → TO PIN "J"
 - (VIO/YEL) → TO PIN "K"
 - (VIO) → TO PIN "F"
 - (BLU/WHT) → TO PIN "C"
 - (BRN/YEL) → TO PIN "A"
 - (RED) → TO PIN "E"
 - (YEL) → TO PIN "B"
 - (RED/WHT) → TO PIN "D"
- TO J402



Gate Board, Pin D

Pulse Audio Out

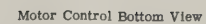
Vertical - 50 millivolts per cm, AC
coupled. Center line approxi-
mately 2.3vdc

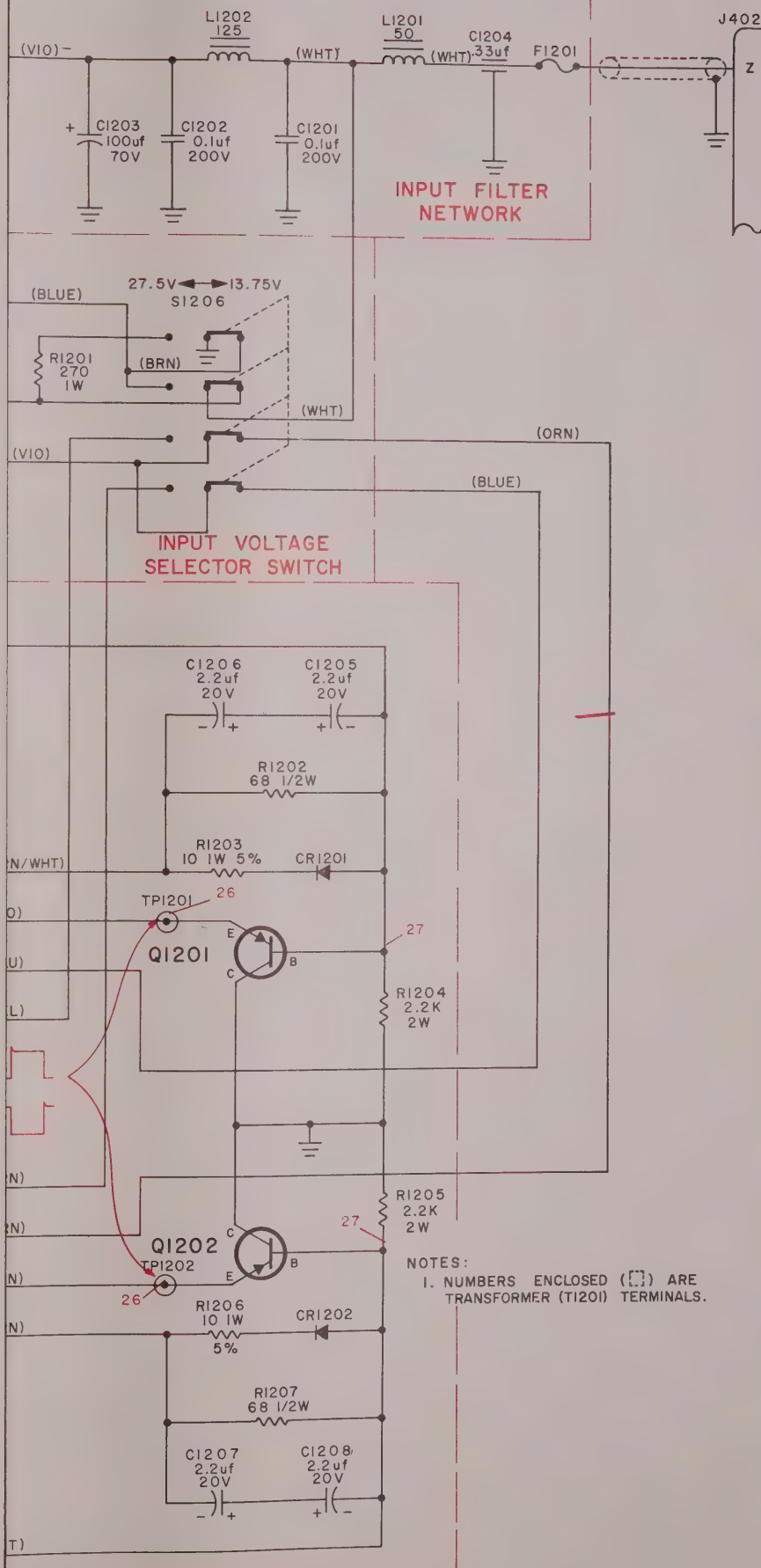
Scope Sync - Internal

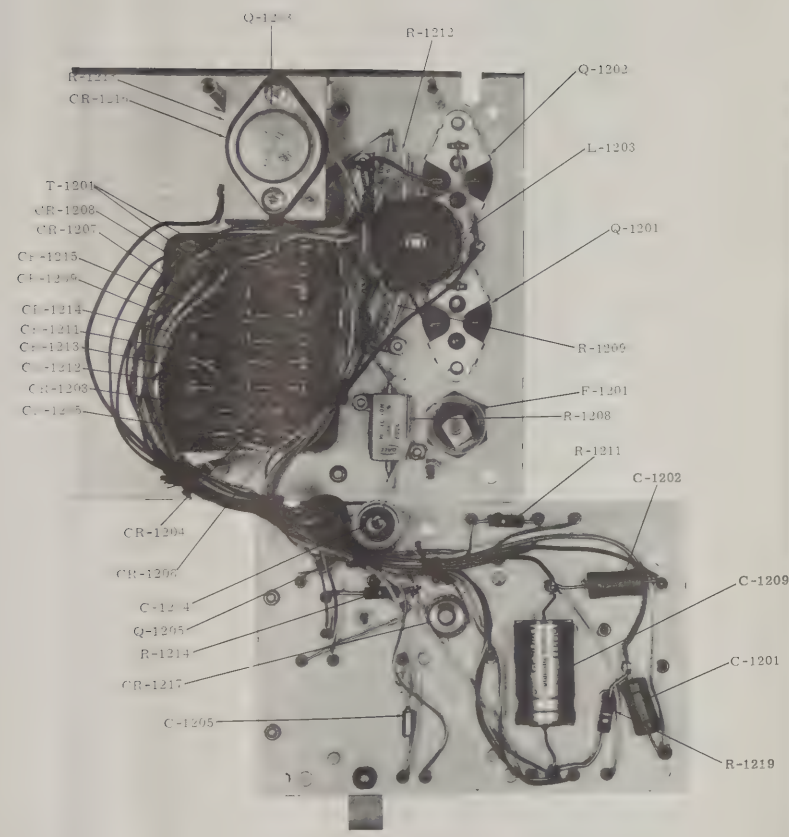
1350 prf Squitter, no return

Horizontal - 0.5 millisecond per cm.

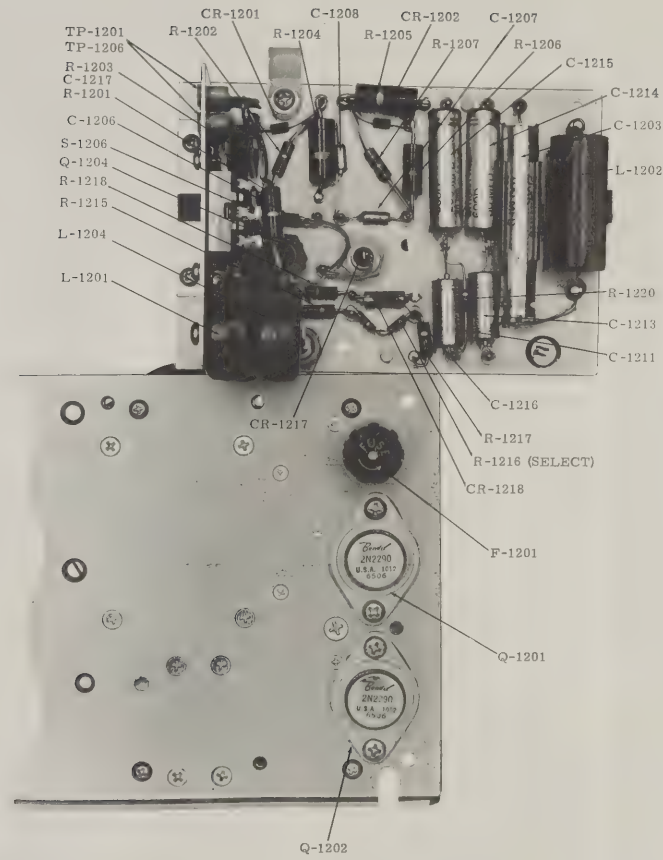
Figure 7-10A. Gate Circuit Waveforms (Sheet 2 of 2)







Power Supply Section Front View



Power Supply Section Rear View

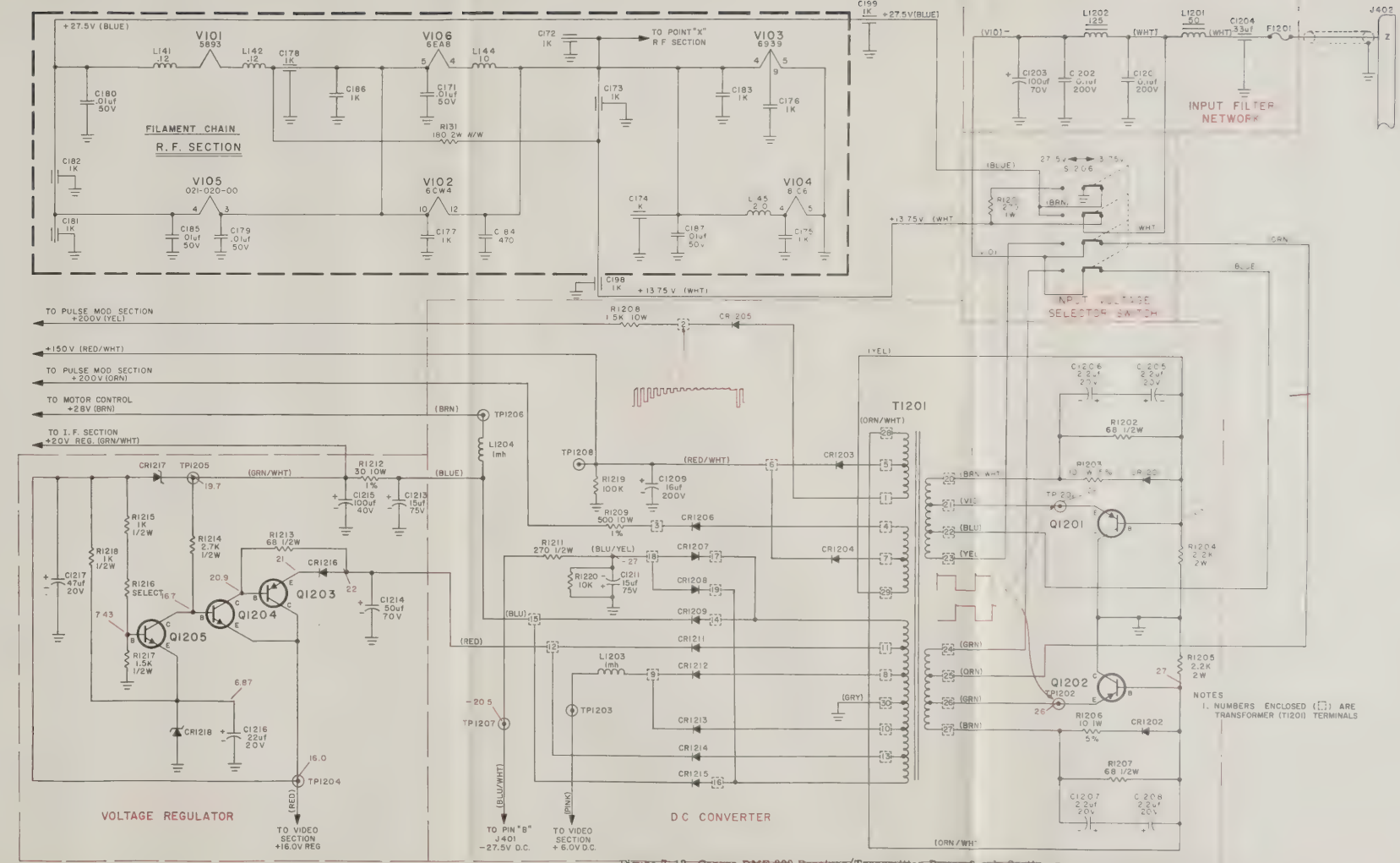
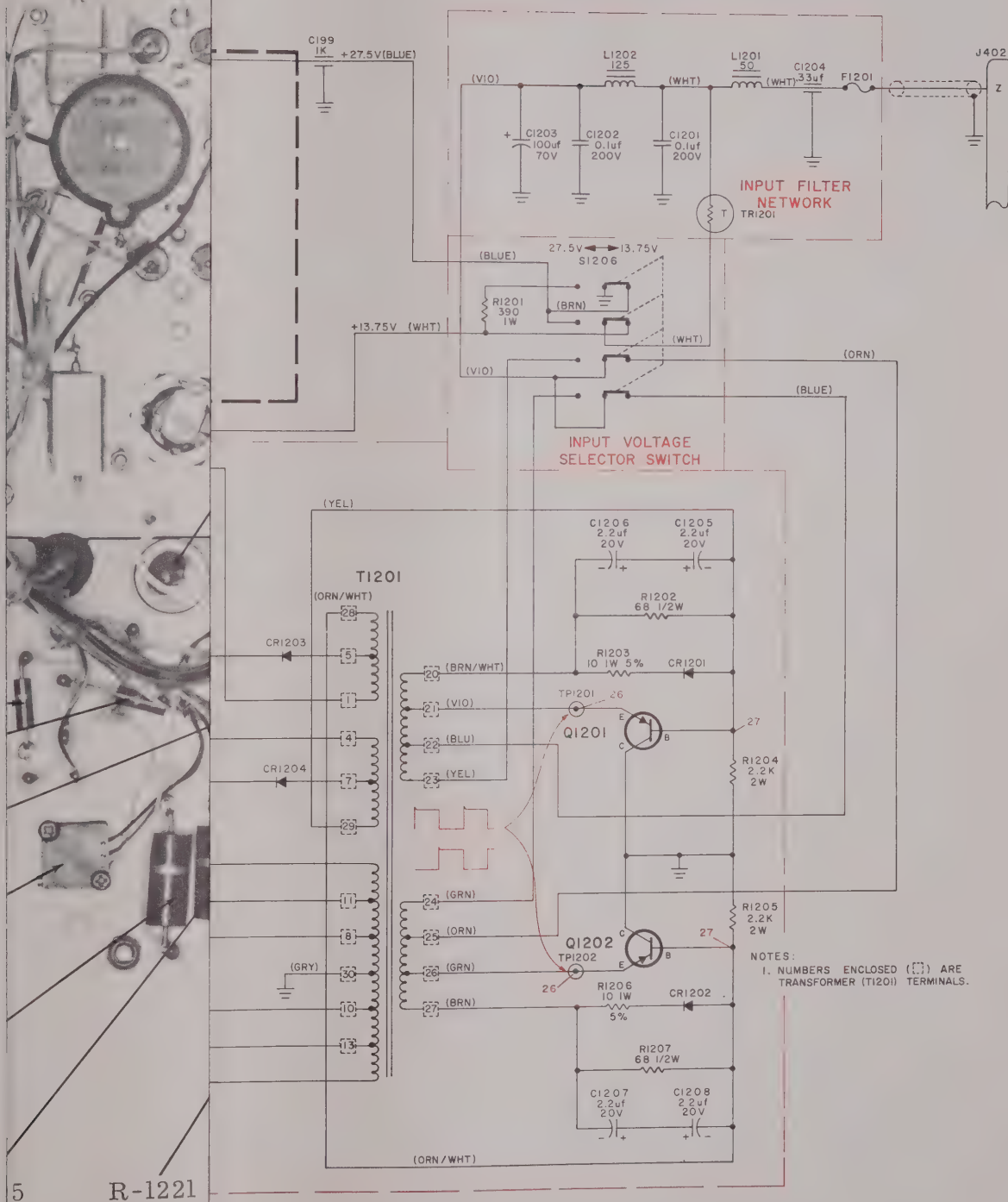
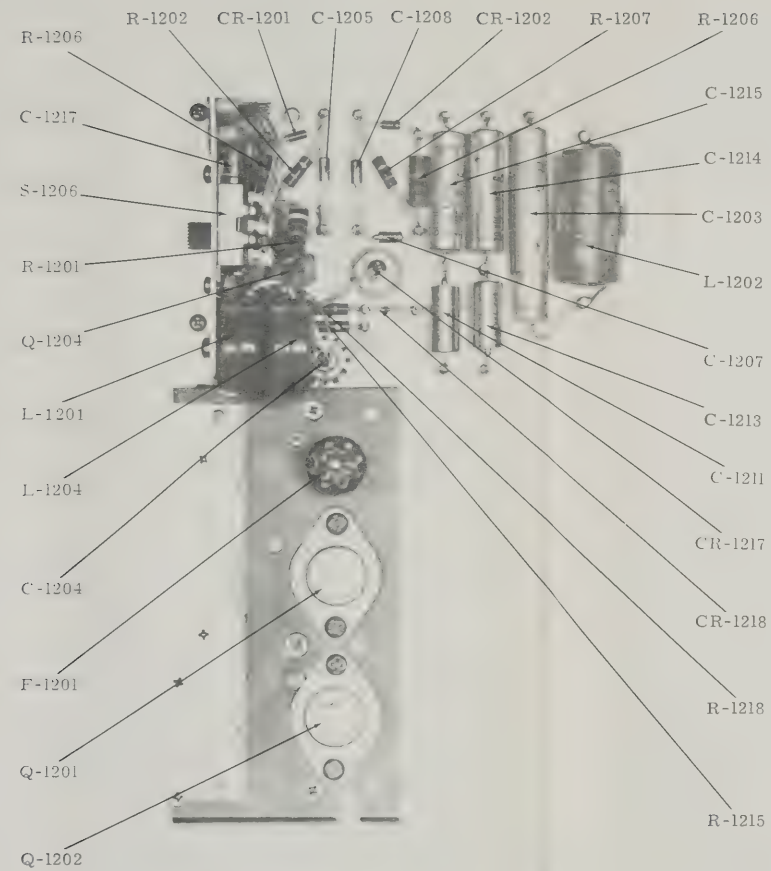
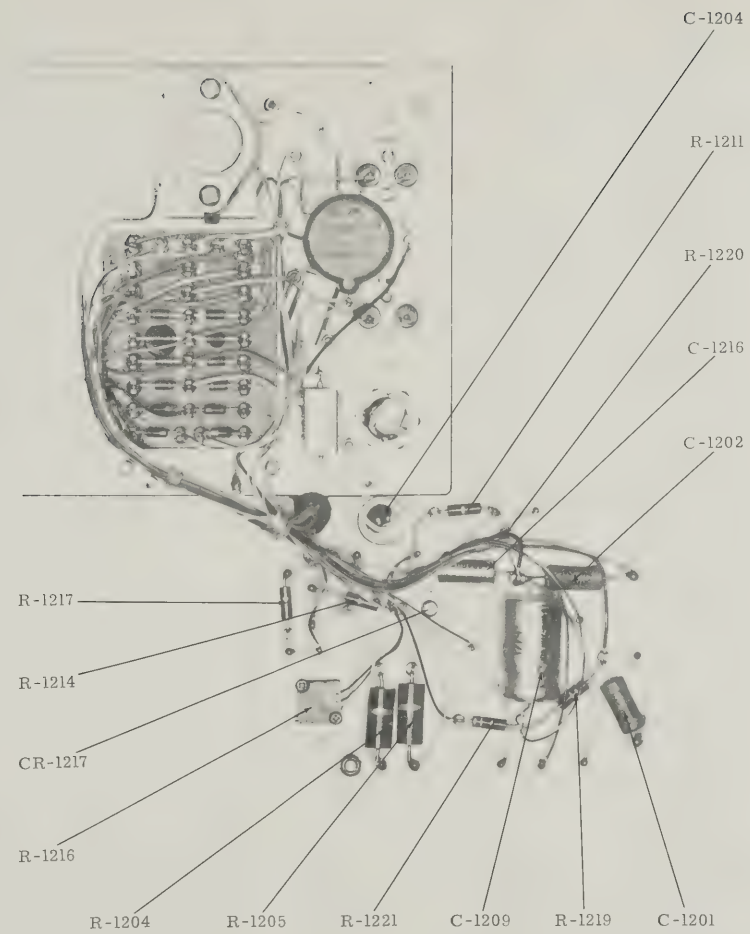


Figure 7-12. Cessna DME 800 Receiver/Transmitter Power Supply Section

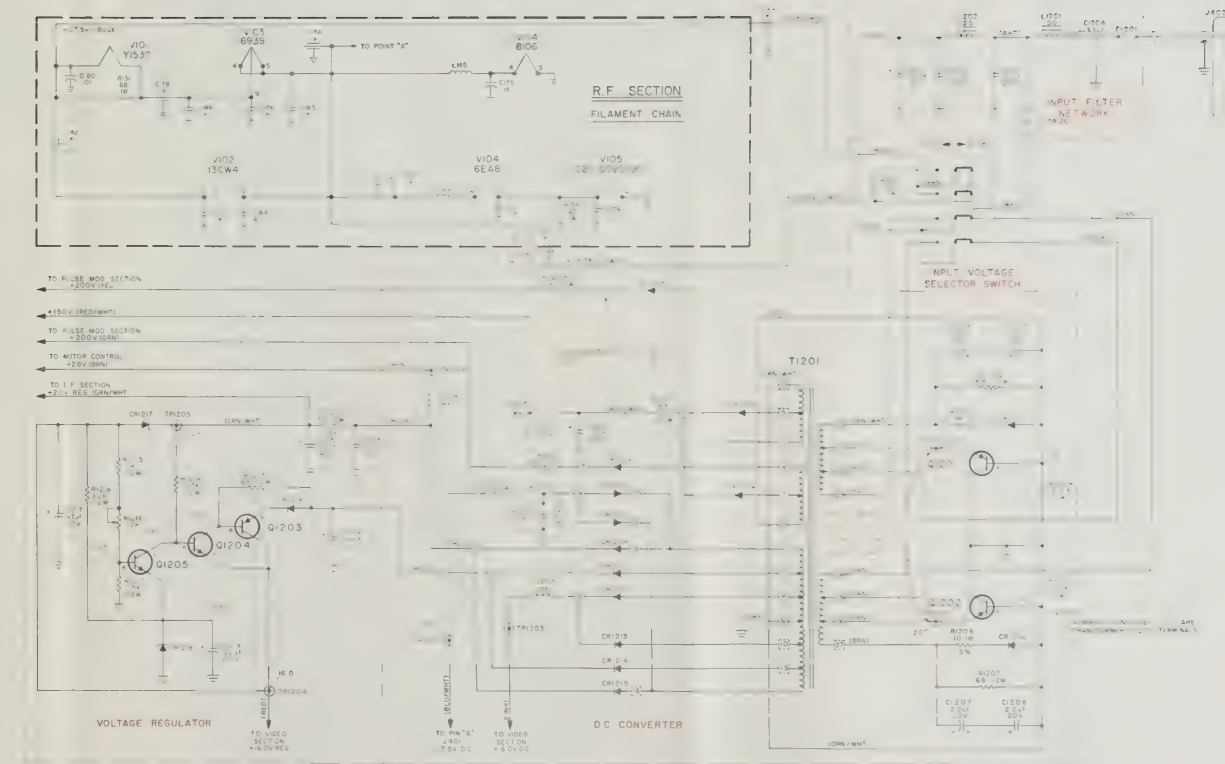




Cessna DME 800 Power Supply Section, Rear View High Power Version

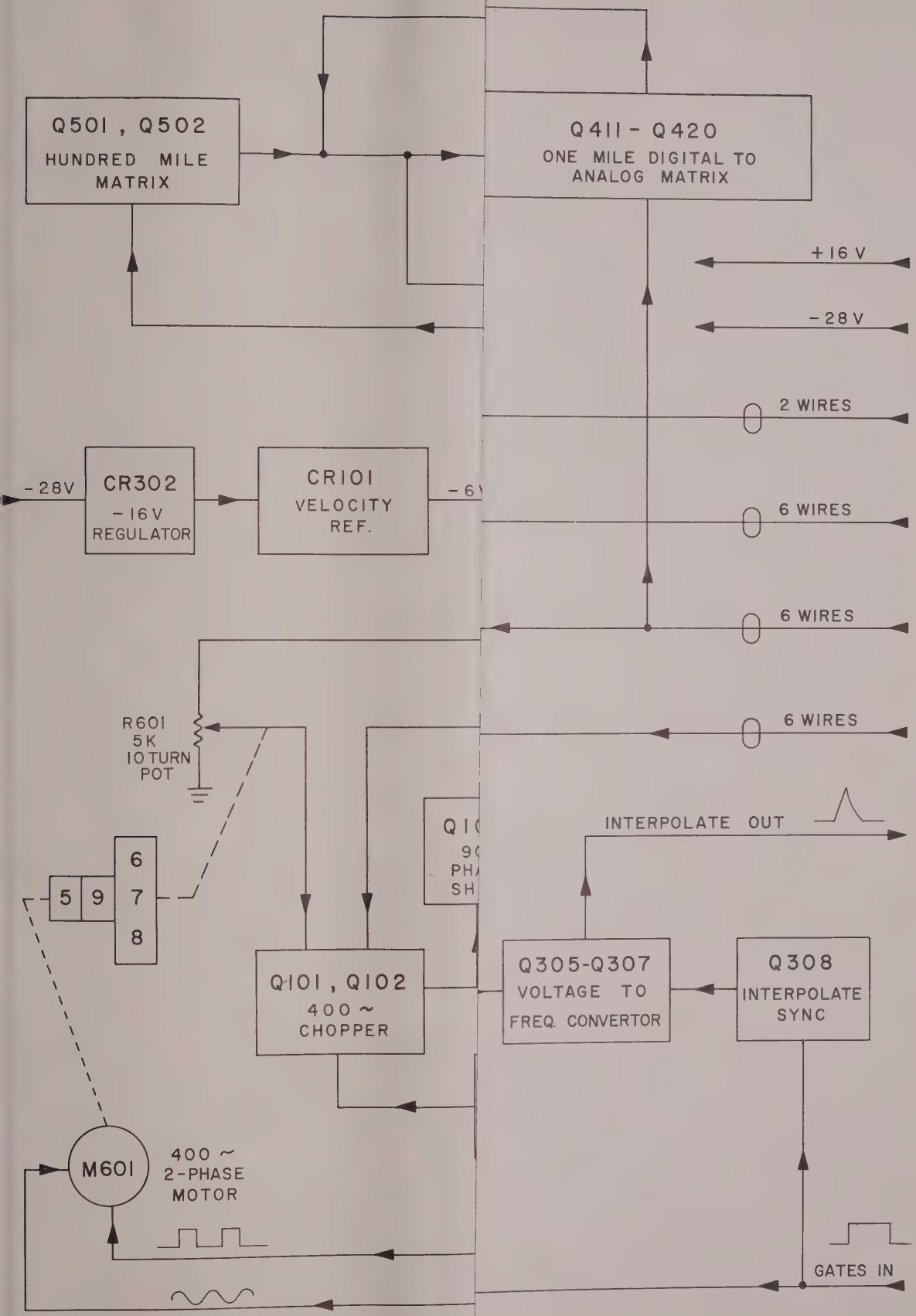


Cessna DME 800 Power Supply Section, Front View High Power Version



CESSNA DME 800 UNITS 1400 AND ON

Figure 7-12A. Cessna DME 800 Receiver/Transmitter Power Supply Section High Power Version



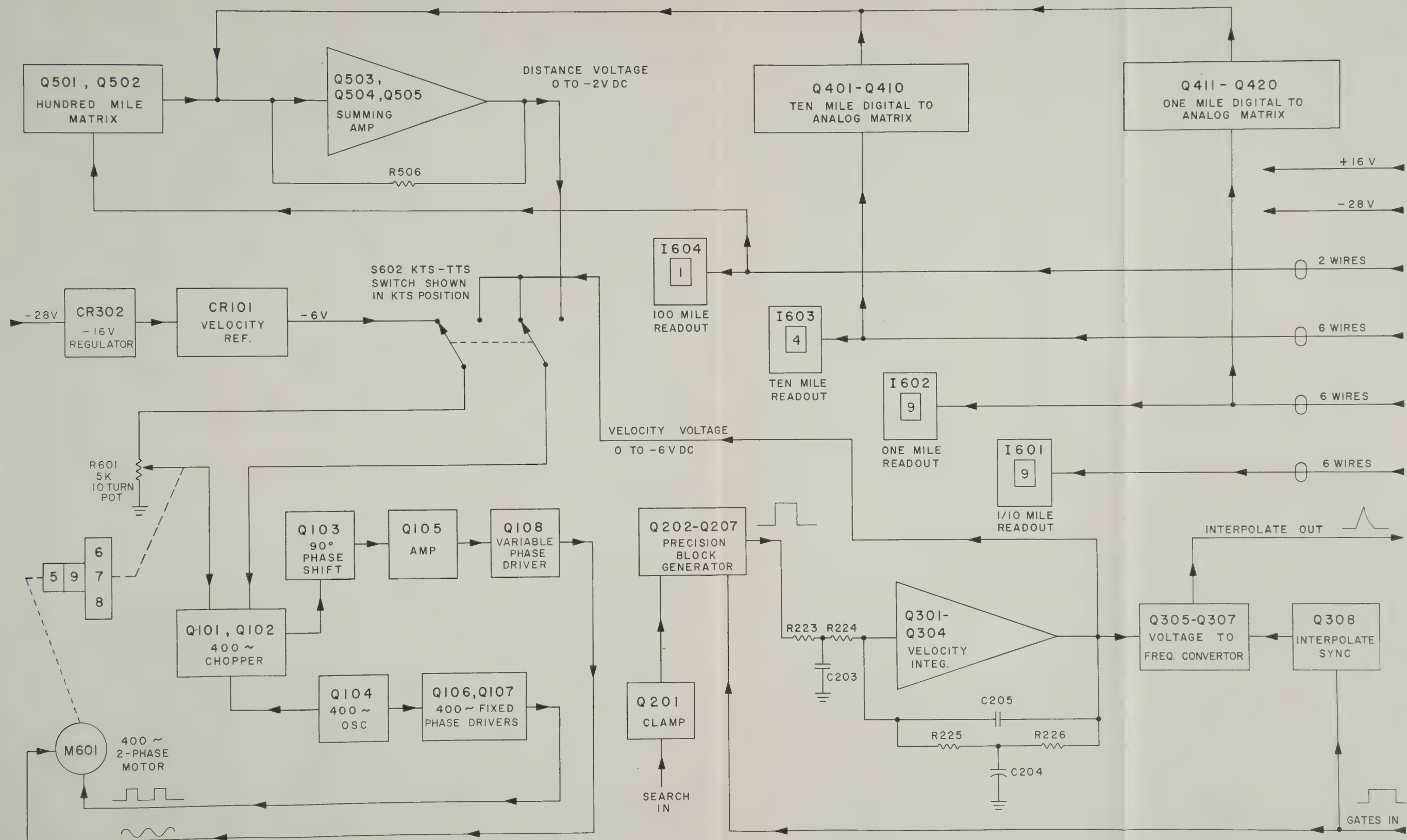
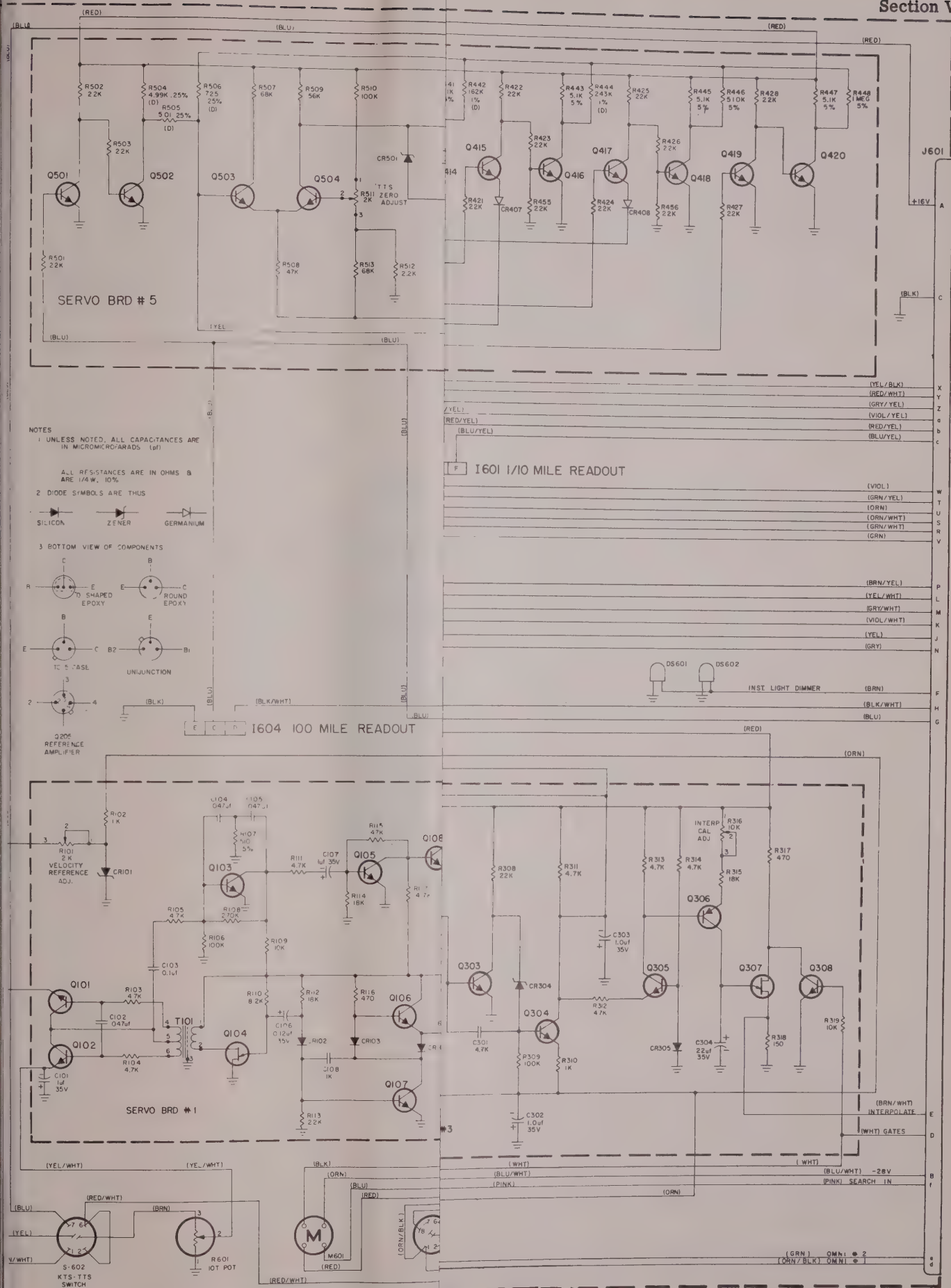
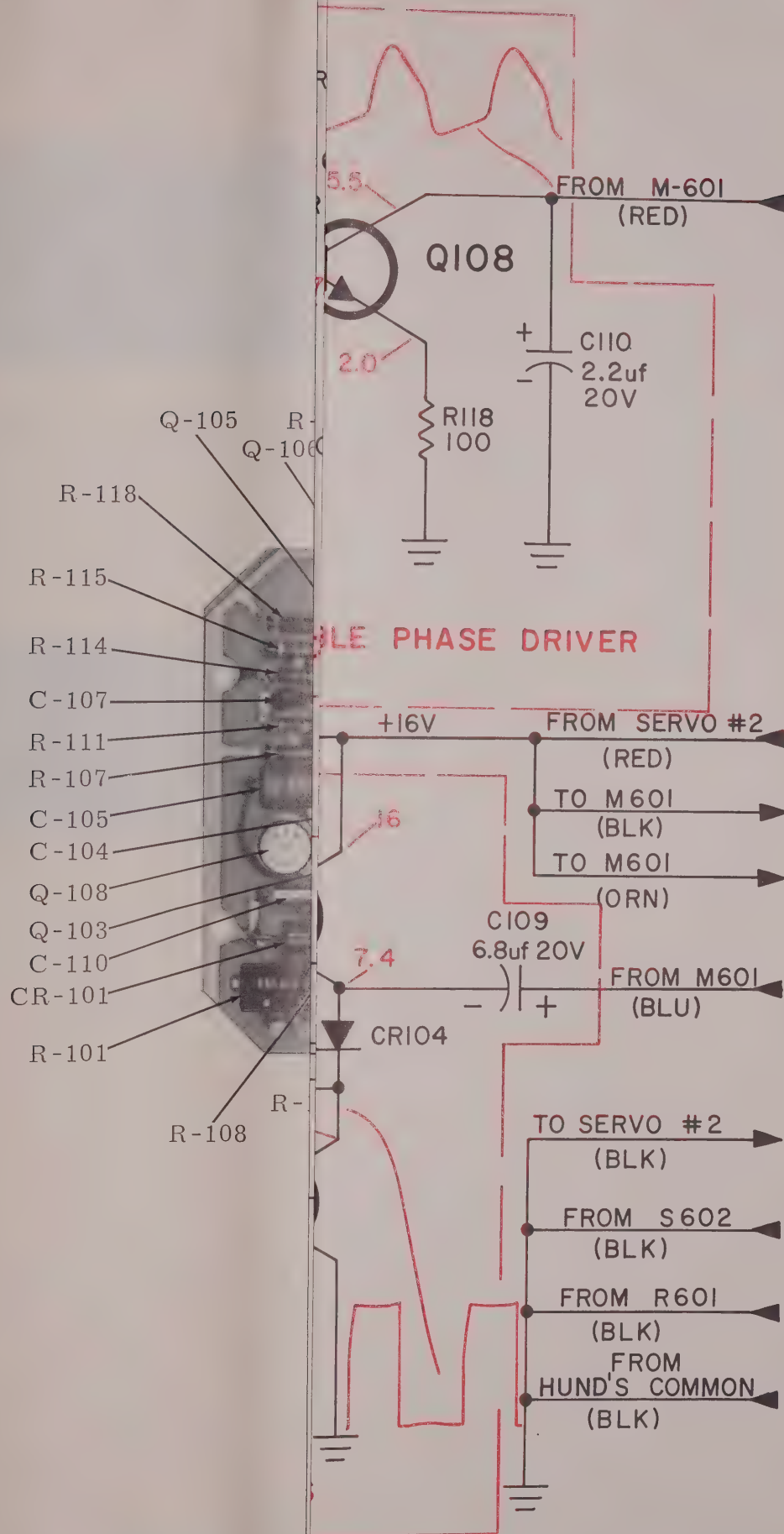
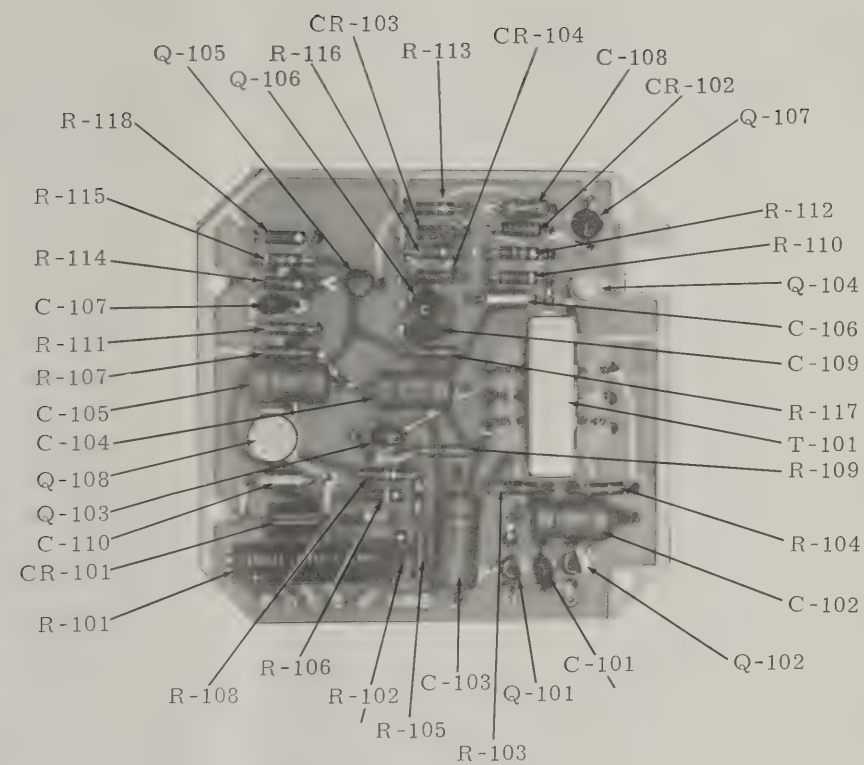


Figure 7-13. Cessna DME 800 Indicator Block Diagram









Servo Board No. 1

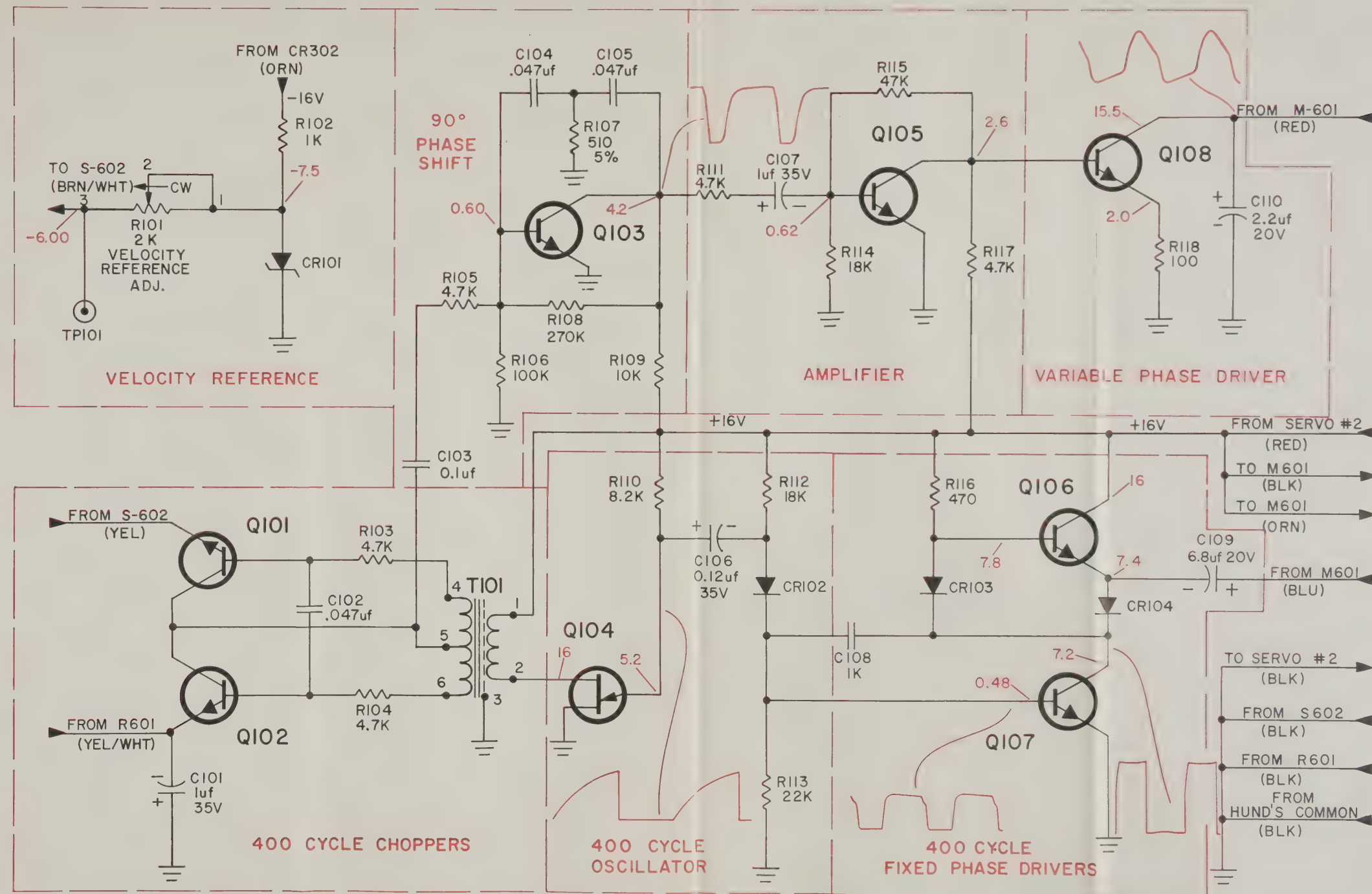
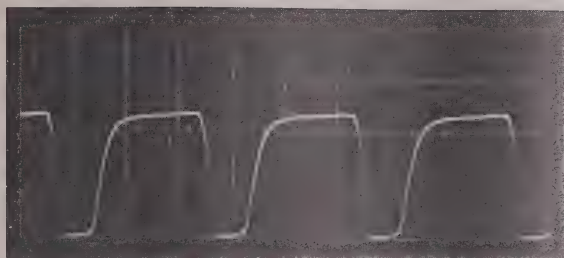


Figure 7-15. Cessna DME 800 Indicator Servo Board No. 1



Q-103 Collector

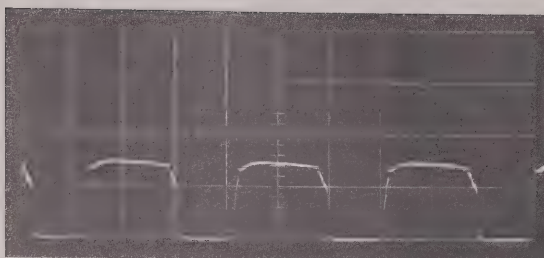
Motor running, numbers decreasing

Vertical - 5 volts per cm.

Bottom Line = 0 volts

Scope Sync - Emitter of Q-104

Horizontal - 1 millisecond per cm.



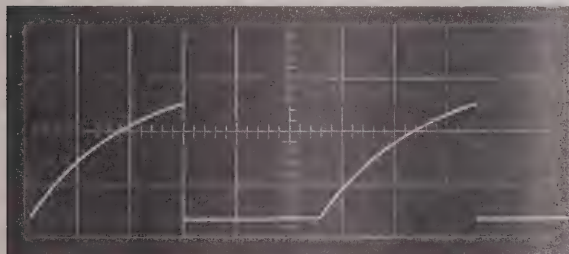
Q-107 Base

Vertical - 0.5 volts per cm.

Bottom Line = 0 volts

Scope Sync - External from Q-104 Emitter

Horizontal - 1 millisecond per cm.



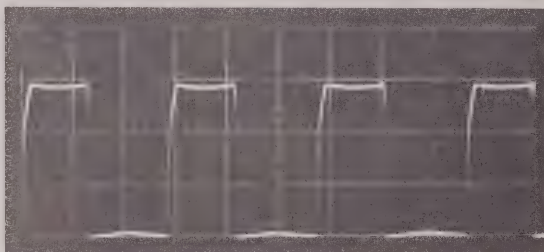
Q-104 Emitter

Vertical - 5 volts per cm.

Scope Sync - Internal

Bottom Line = 0 volts

Horizontal - 0.5 milliseconds per cm.



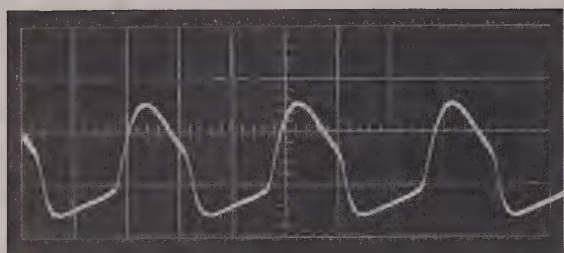
Q-107 Collector

Vertical - 5 volts per cm.

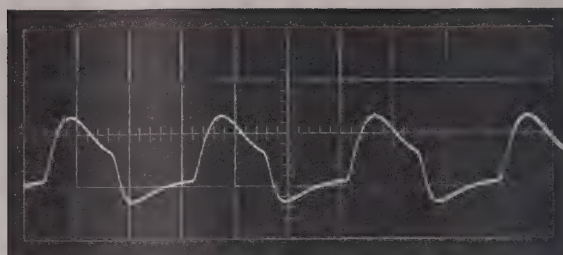
Bottom Line = 0 volts

Scope Sync - External from Q-104 Emitter

Horizontal - 1 millisecond per cm.

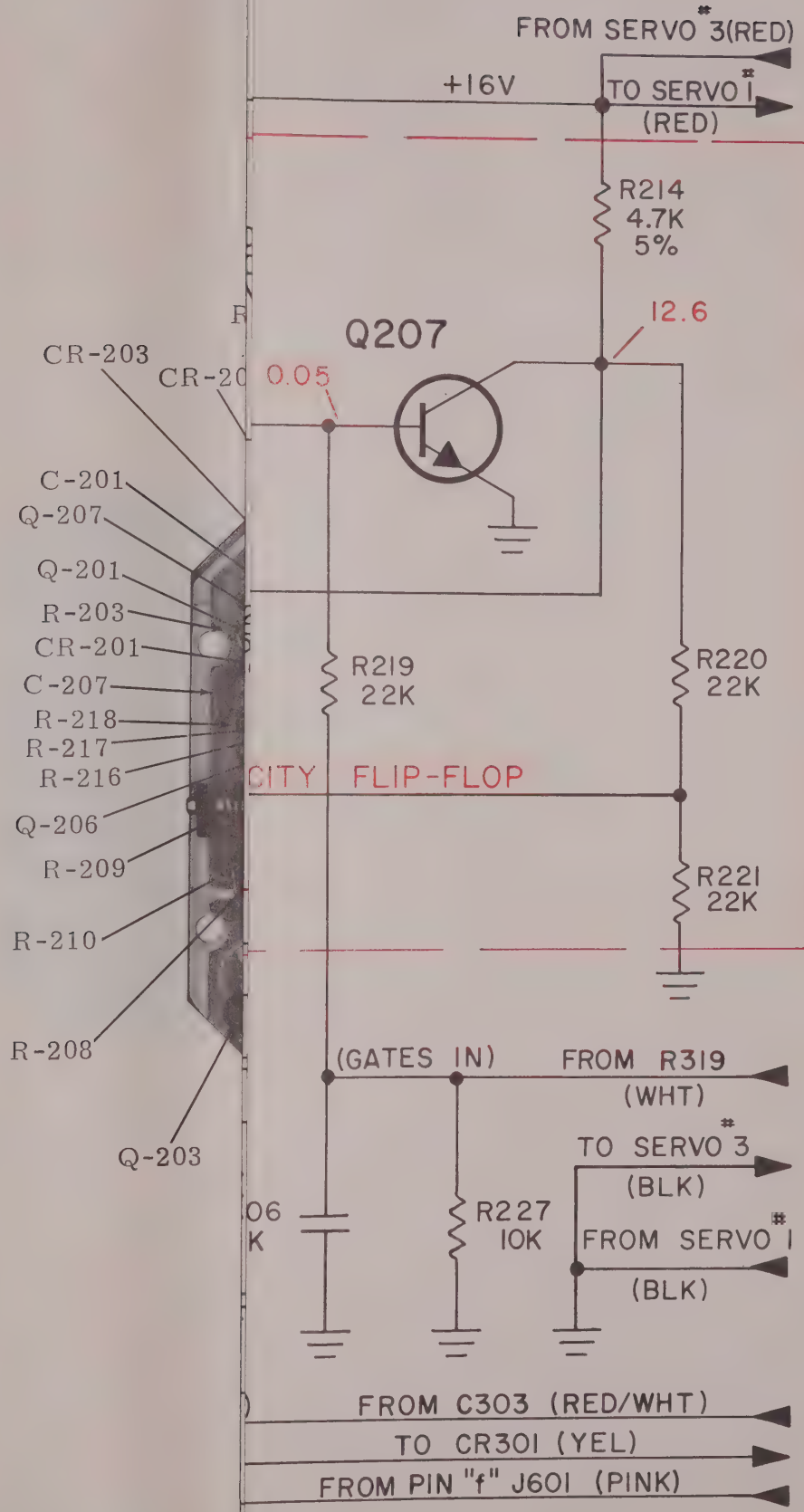


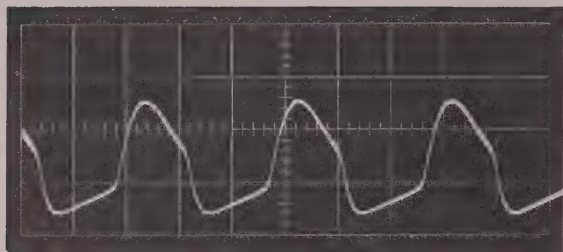
Q-108 Collector
Motor running, numbers decreasing
Vertical - 10 volts per cm.
External Sync - Q-104 Emitter
DC coupled
Bottom Line = 0 volts
Horizontal - 1 millisecond per cm.



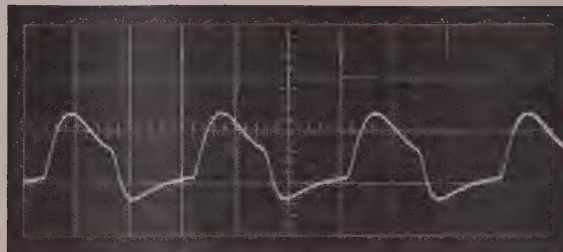
Q-108 Collector
Motor running, numbers increasing
Vertical - 10 volts per cm
DC coupled
Bottom Line = 0 volts
Scope Sync - External from Q-104 Emitter
Horizontal - 1 millisecond per cm.

Figure 7-15A. Indicator Servo Board #1 Waveforms (Sheet 2 of 2)





Q-108 Collector
Motor running, numbers decreasing
Vertical - 10 volts per cm.
External Sync - Q-104 Emitter
DC coupled
Bottom Line = 0 volts
Horizontal - 1 millisecond per cm.



Q-108 Collector
Motor running, numbers increasing
Vertical - 10 volts per cm
DC coupled
Bottom Line = 0 volts
Scope Sync - External from Q-104 Emitter
Horizontal - 1 millisecond per cm.

Figure 7-15A. Indicator Servo Board #1 Waveforms (Sheet 2 of 2)

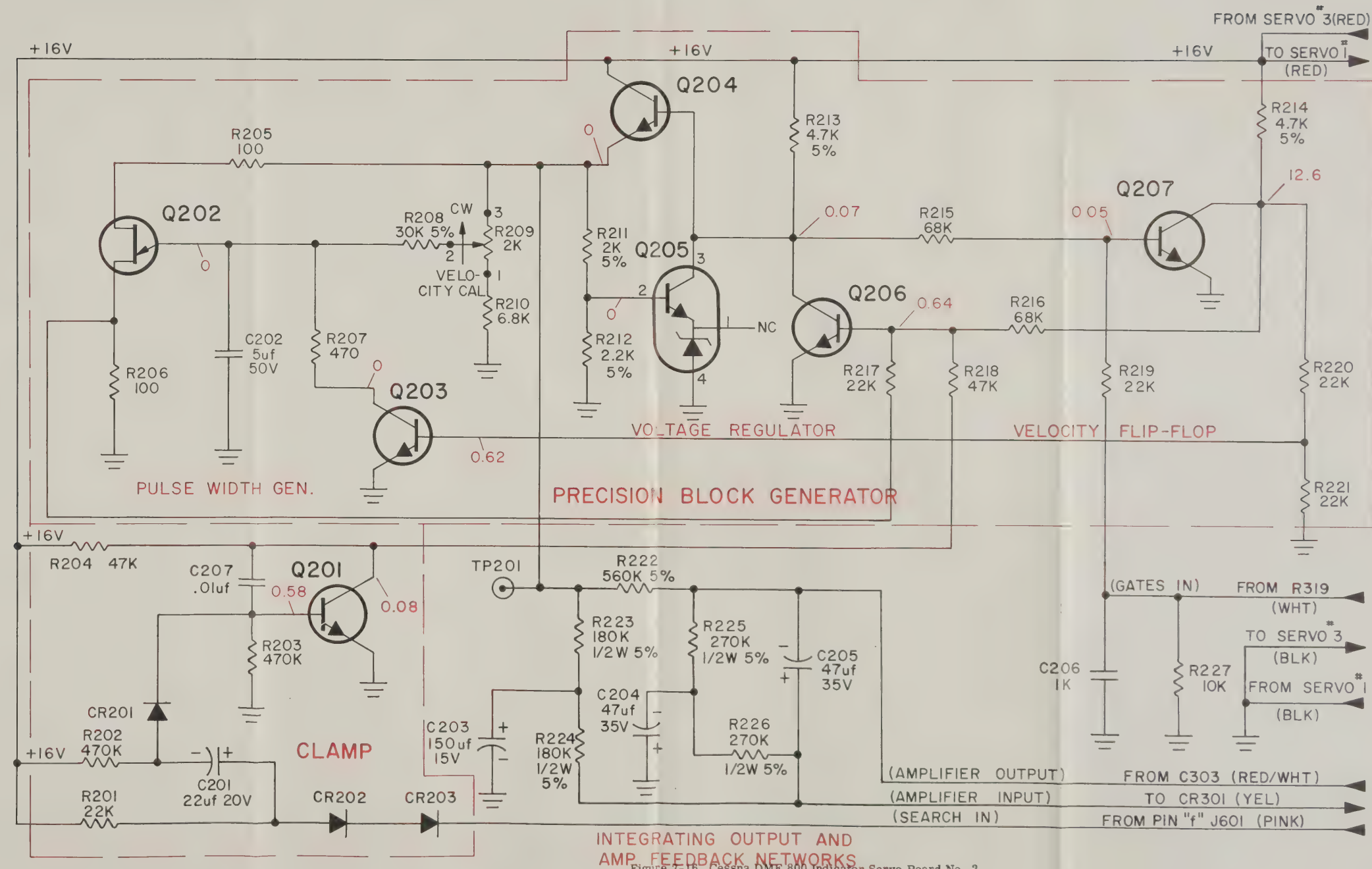
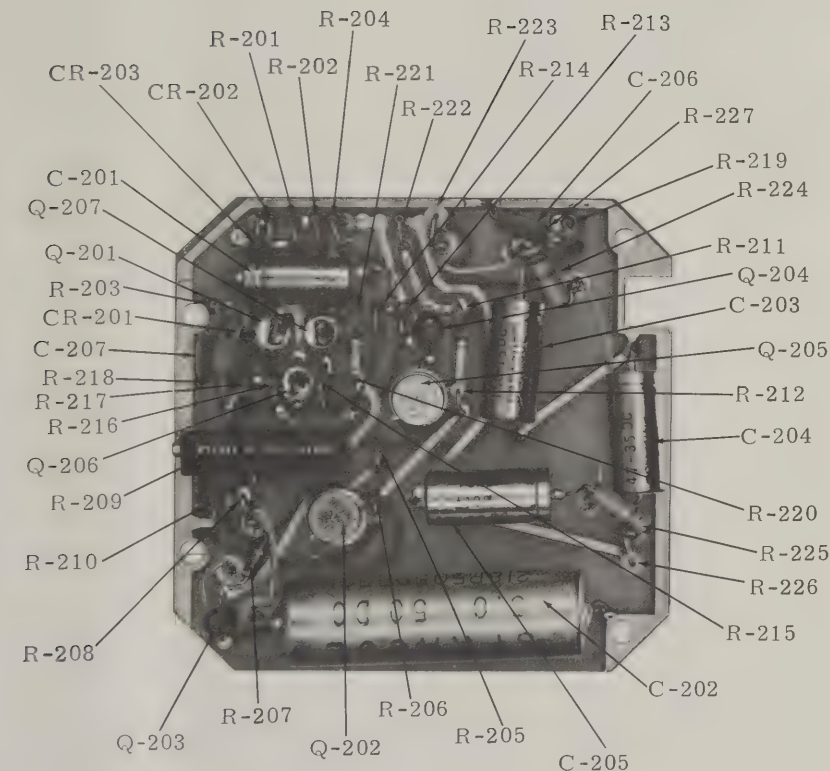
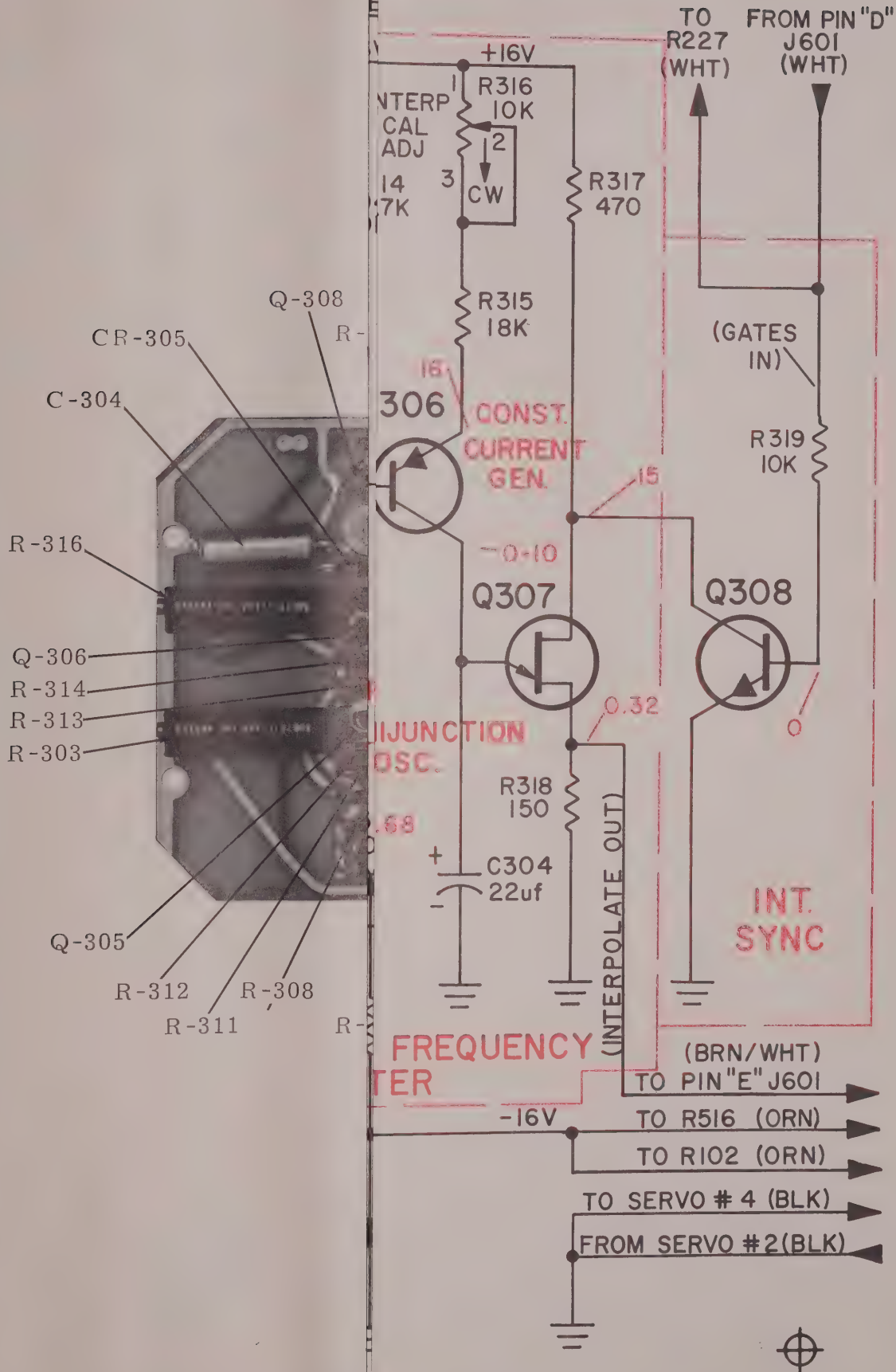
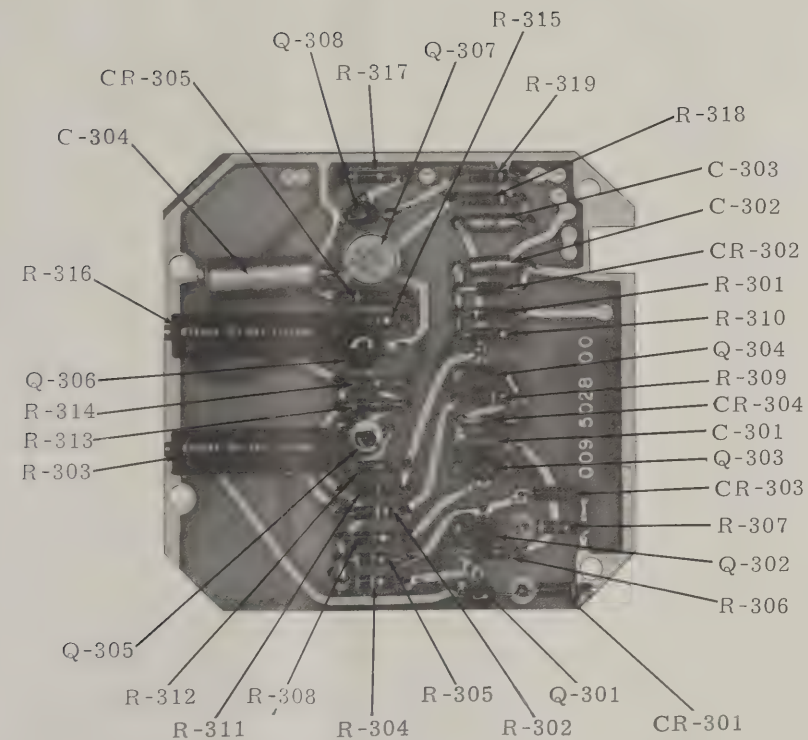


Figure 7-16. Cessna DME 800 Indicator Servo Board No. 2



Servo



Servo Board No.3

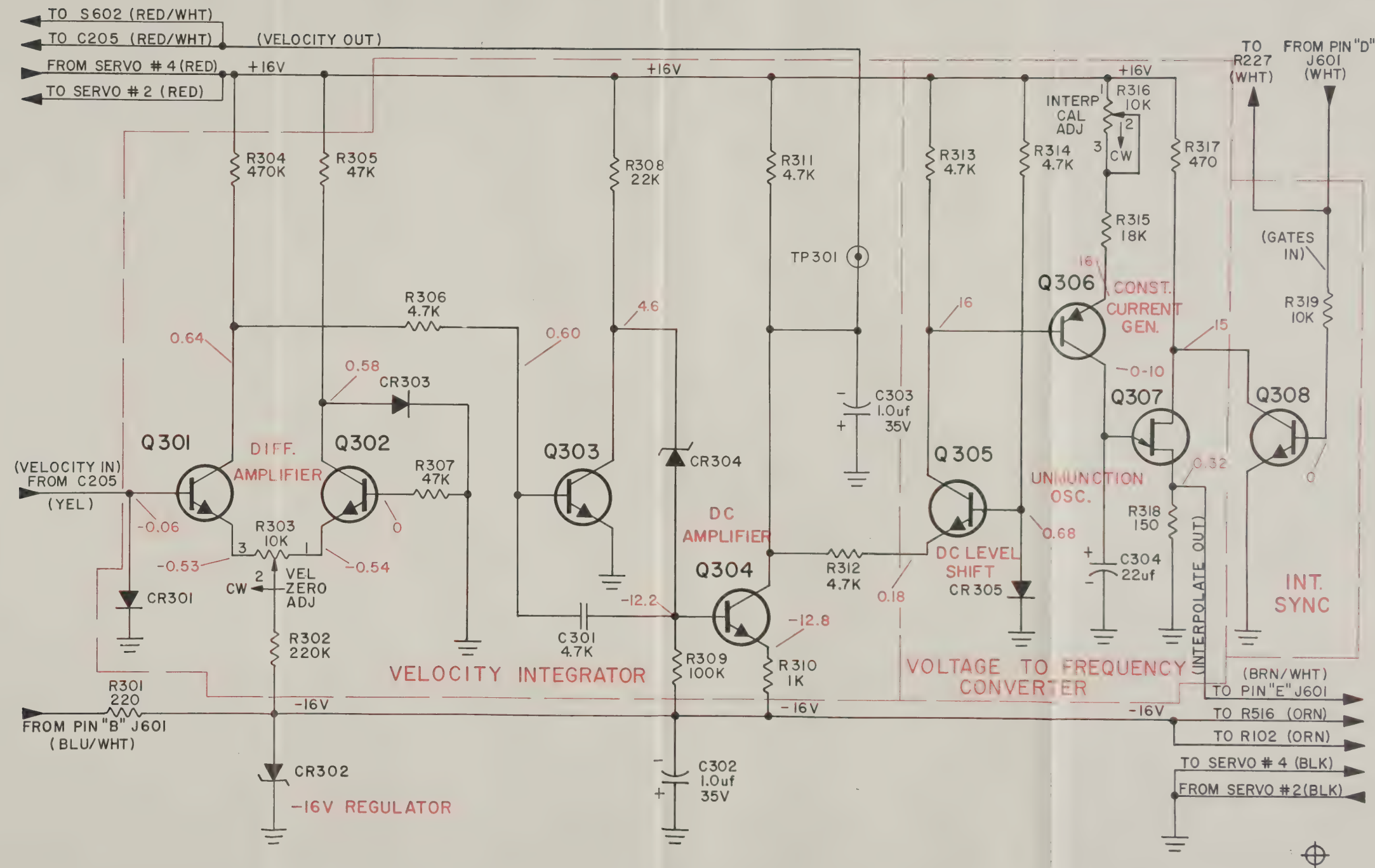
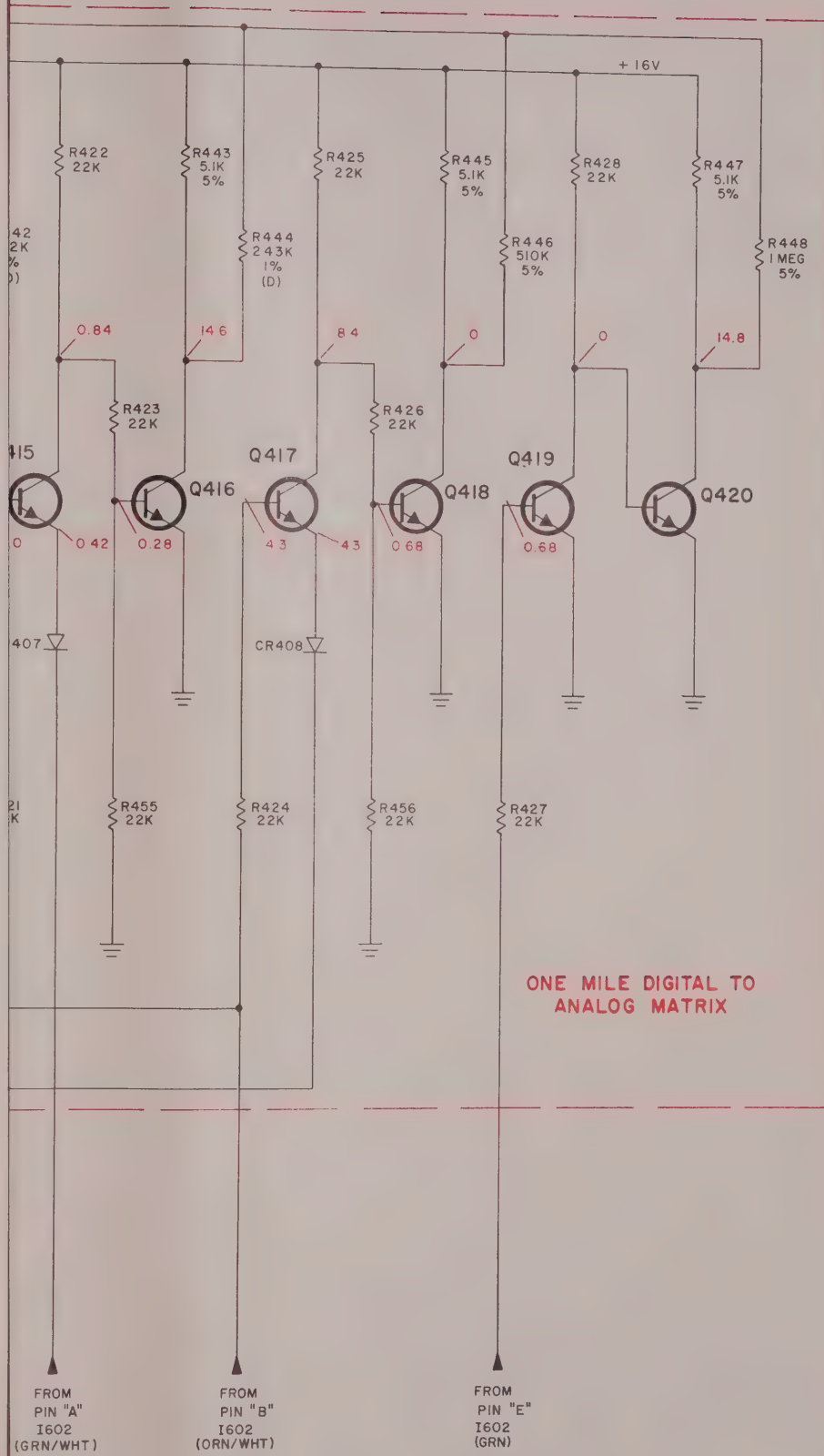
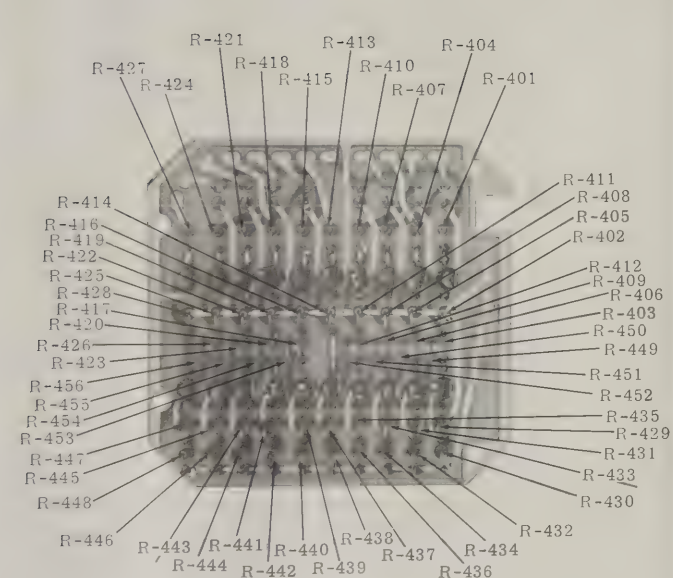


Figure 7-17. Cessna DME 800 Indicator Servo Board No.3

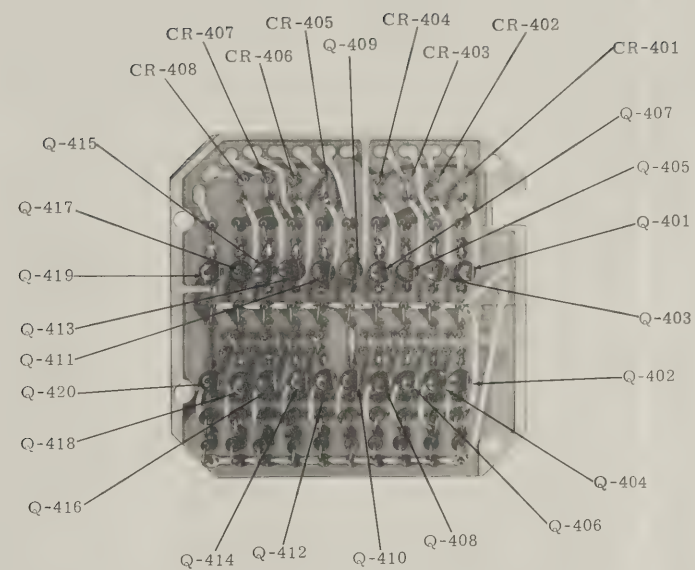


d No. 4





Servo Board No.4 - Resistors



Servo Board No.4 - Transistors

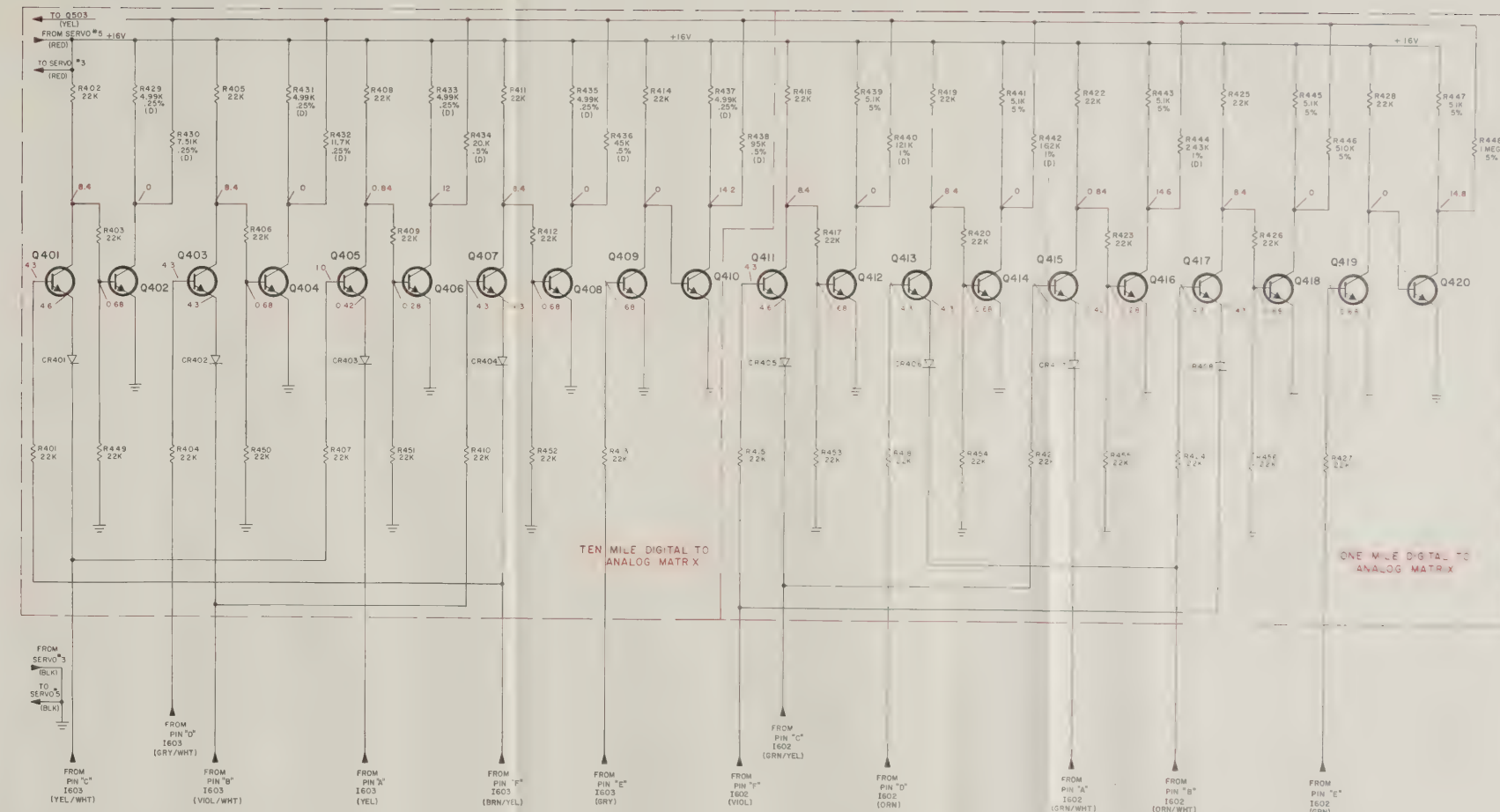
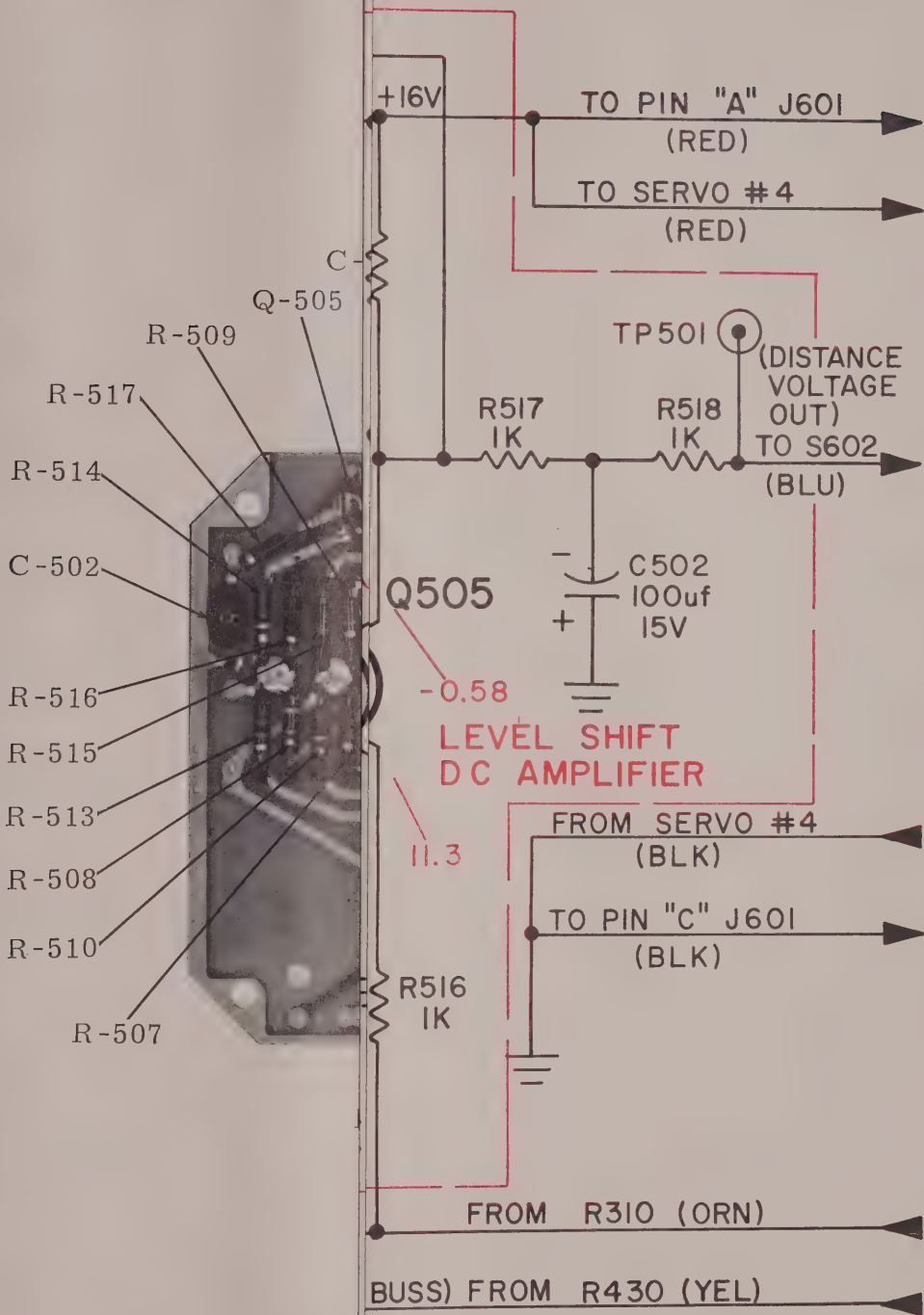
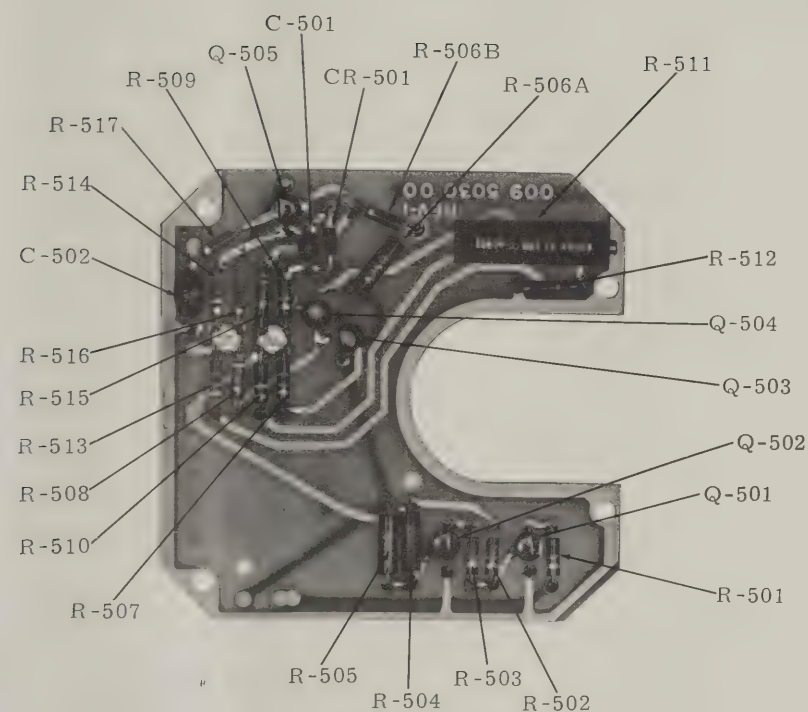


Figure 7-18. Cessna DME 800 Indicator Servo Board No. 4





Servo Board No. 5

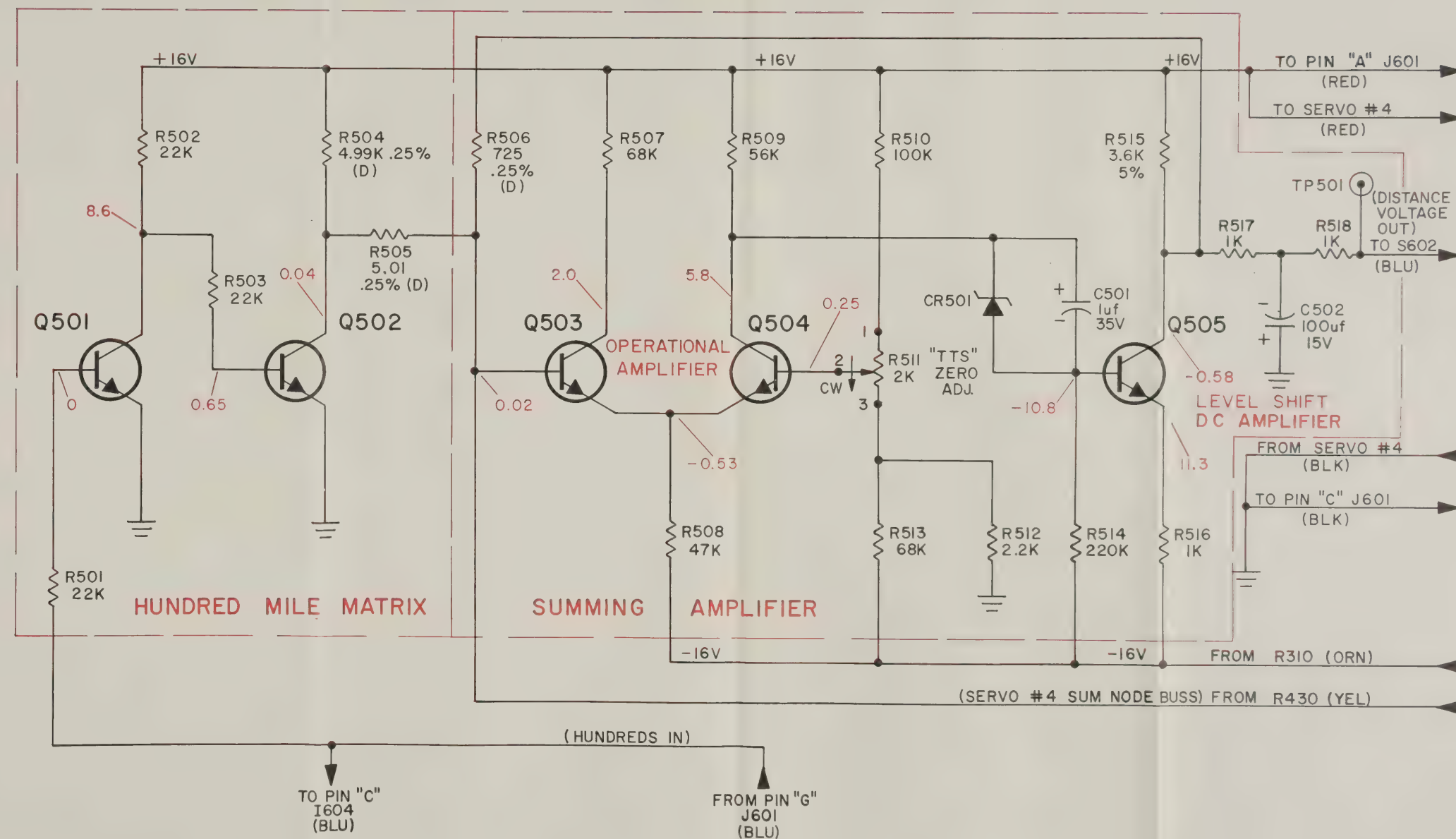
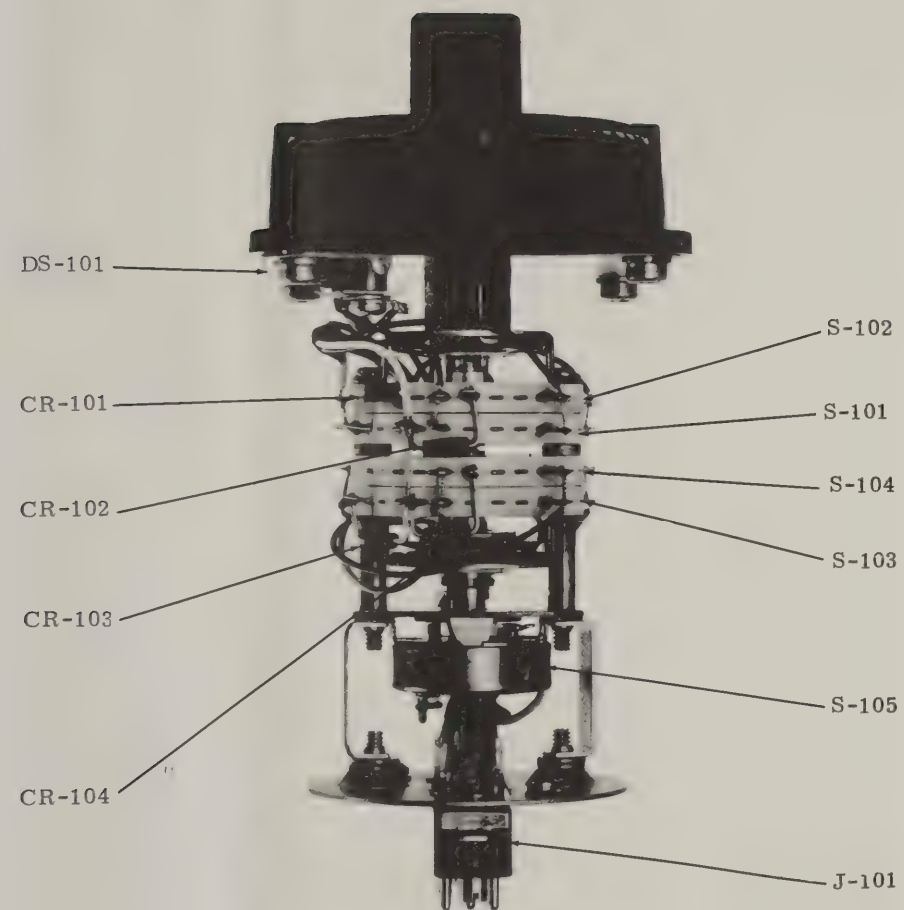


Figure 7-19. Cessna DME 800 Indicator Servo Board No. 5



Top View

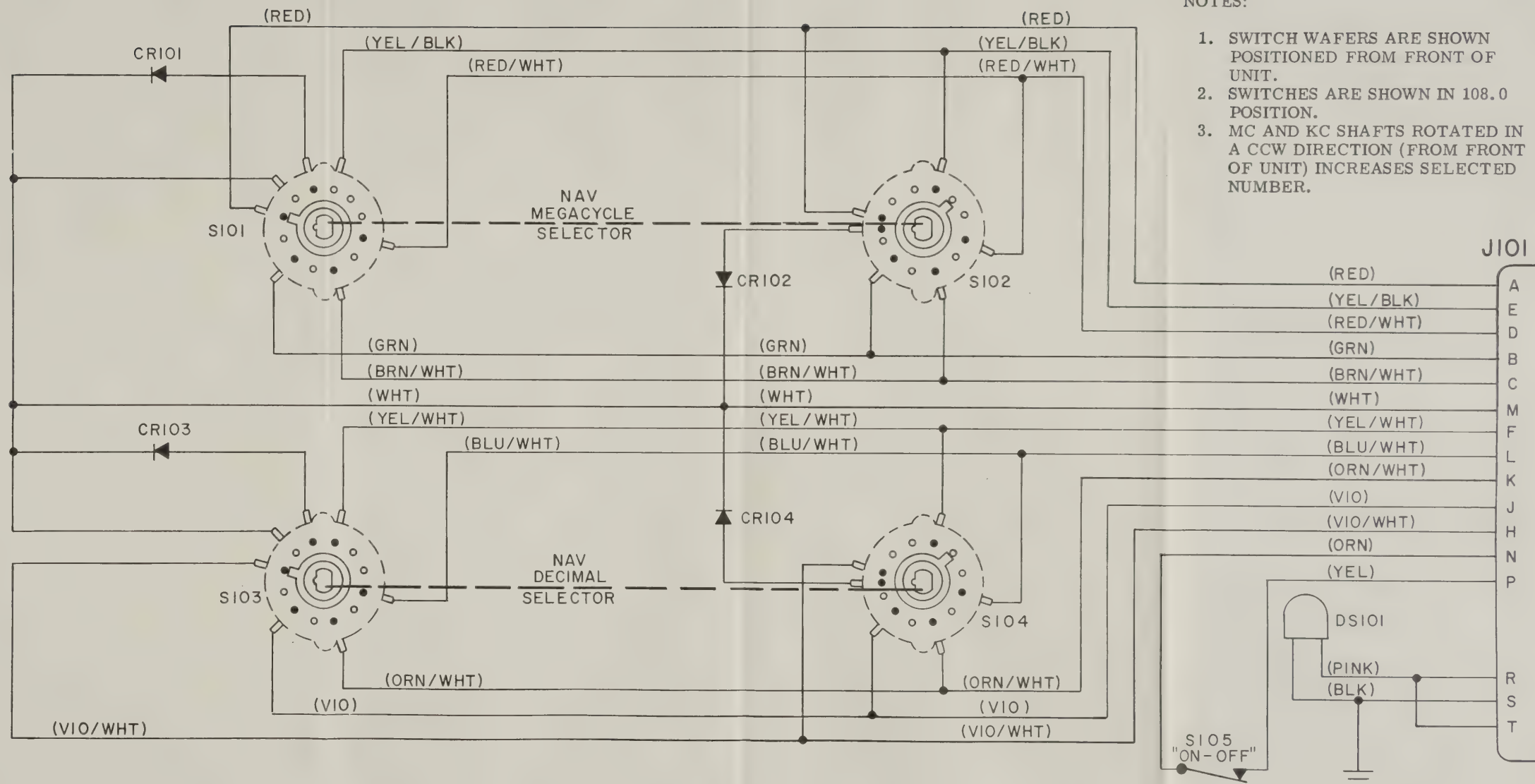


Figure 7-20. Cessna DME 800 Channel Selector Schematic

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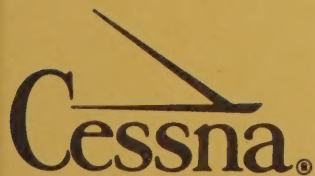
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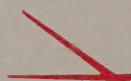




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